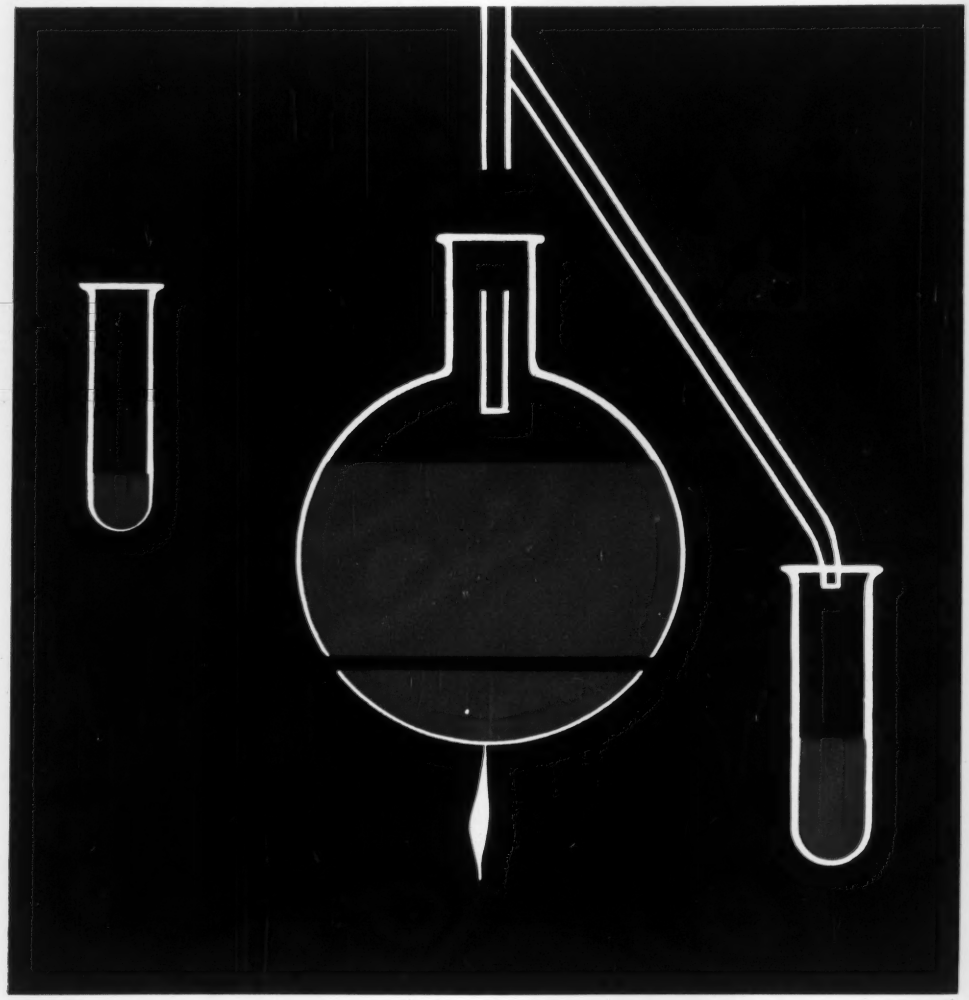
INSTRUMENTS AND CONTROL SYSTEMS

INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER



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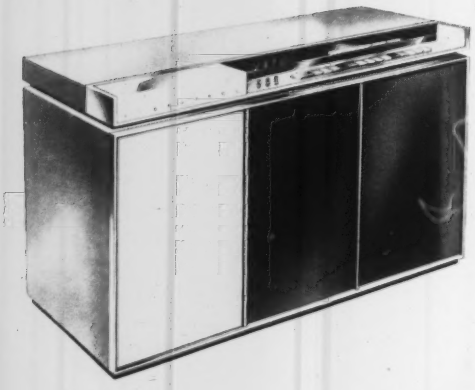

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NUMBER: 8, expandable to 512 with additional optional plug-in components.
SEQUENCE: By computer command; changeable by program.
VOLTAGE RANGE: 0-1 and 0-10 (or more) volts d.c.
MANUAL: Flexowriter and punched paper tape.
DIGITAL CLOCK: Internal, pure binary, real time to provide time of day for logging.

OUTPUTS
Flexowriter and punched paper tape; and computer logic producing 10-bit addressable word to actuate relays for control signals.
SPEED AND NUMBER: 66 outputs per second; time-sharing permits unlimited number.
SEQUENCE: By computer command; changeable by program.
TIME READOUT: From digital clock.
TYPICAL OPTIONAL CONTROL FUNCTIONS AVAILABLE: Alarms, voltage level, bridge balance, relay closure, setpoint, reset rate, proportional band, variable time delay, recorder, plotter.

GENERAL SPECIFICATIONS
COMPUTER TYPE: General-purpose digital.
NUMBER BASE: Binary.
MODE OF OPERATION: Serial.
INSTRUCTION TYPE: Single address.
NUMBER OF DIFFERENT INSTRUCTIONS: 16
MEMORY TYPE: Magnetic drum.
MEMORY CAPACITY: 4096 words.
WORD LENGTH: 30 bits plus sign.
CLOCK FREQUENCY: 136 KC
ADD TIME (Excluding Access): 0.25 milliseconds.
MULTIPLY TIME (Excluding Access): 15 milliseconds.
WEIGHT: 1000 lbs. nominal.
SIZE: 30" x 42" x 60".
POWER REQUIREMENTS: 117 volts (±10%) 17 amperes 60 cycles.

OPTIONAL EQUIPMENT
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MAGNETIC TAPE: Storage for additional input, output, and computing information.
MAGNETIC-CORE MEMORY: For quick access to stored data.
PUNCHED CARD INPUT.
LINE PRINTER: High speed data-logger printing 14 digits at a time.
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RELAY SENSING EQUIPMENT: For changing computer program in accordance with plant or product requirements.
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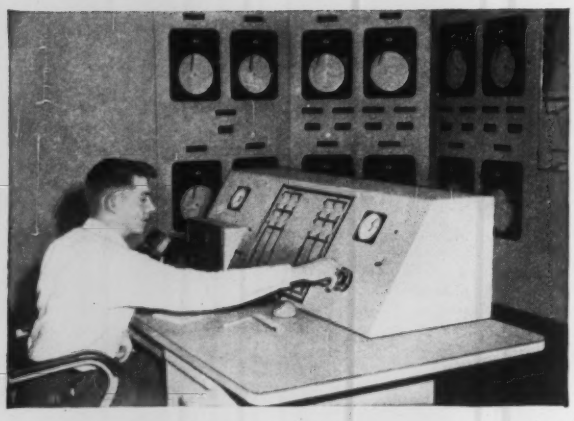

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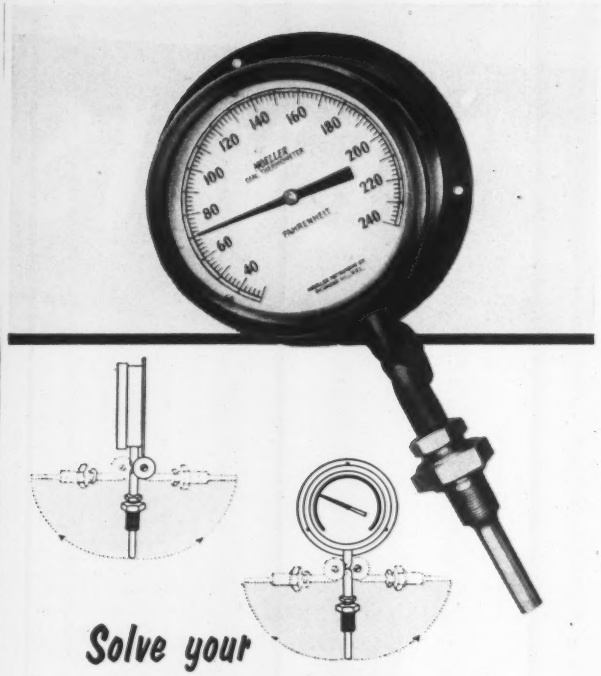

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Formerly INSTRUMENTS and AUTOMATION

JUNE 1959

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INSTRUMENT industry faces an industry without specialists required for new techniques

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Instrument Prices Are Not High, 872

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Viscosity Of Fluids, 876

R.A. MINARD—many process operations can be best controlled by fluid viscosity—but one must know the viscosity group

Automatic Viscosity Control, 878

AUSTIN S. NORCROSS—viscosity is used for automatic control of many common processes

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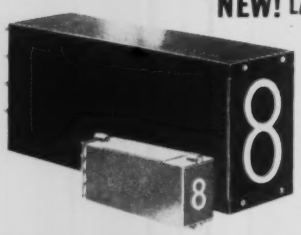

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INSTRUMENTS AND CONTROL SYSTEMS

VOL. 32 NO. 6 JUNE, 1959

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An Adaptable Printer with Day In-Day Out Reliability

Understandably, Panellit's requirements for a digital printer were strict. The Skokie, Illinois firm's recording annunciator, which monitors trouble in equipment operations, has to have around-the-clock reliability. It has to indicate what went wrong, exactly when it went wrong, and for how long. In many instances, the printer must operate at remote stations, unattended. Panellit chose CMC's new digital printer to provide this high degree of dependability.

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KEY SPECIFICATIONS • Model 400C Digital Printer

Print-out capacity 6 digits standard, up to 12 on special order. Accuracy determined by basic counting instrument... display time 0.2 seconds minimum, maximum controlled by counter or system. Weight 64 lbs.

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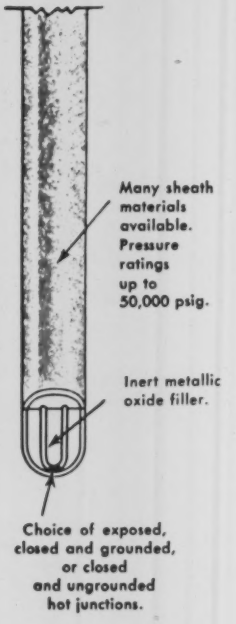
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Trinox units offer the user a single unit combining the protection of a thermowell and the accuracy of a fine thermocouple. The thermocouple is encased in an inert metallic oxide within a metal sheath with the proper process connection and junction.

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to the editor

Editor, I&CS:

I am very much impressed with the work that you have done in the public schools in Pittsburgh and will continue to learn more about that instruction with the thought of introducing some here.

M. Marcus Kiley
Deputy Superintendent
The Public Schools
of Springfield, Mass.

Editor, I&CS:

Please disregard my letter of April 7th regarding Instrumentation course at Arizona State University. It has since been decided at higher levels to make it one of a highly theoretical nature, so extensive laboratory equipment will not be needed.

James C. Coe
Mesa, Arizona

The previous letter (printed last month) stated Dr. Coe's intention to introduce a course in engineering instrumentation. Instead, we will have another theoretical (instrument-free) course.

Editor, I&CS:

I've just re-read your March editorial entitled Anti Hardwarism—A Threat to American Education, etc. It still sounds like a small boy who is "mad" about something and follows his first impulse which is to lash out blindly at everything around him.

I could take issue with some of the statements made in the first three pages of your article and help to defend others. I do wish to point out that at the high school and beginning college level it is very easy for a course which has some good pieces of hardware to degenerate into a sequence of steps in which the student memorizes the parts and the order in which they are assembled and misses the understanding of the theory or principle involved. Then, you don't even have a good vocational course.

Also, I notice that in the writer's mind there is no distinction between a college and a university and that he seems completely unaware of the part played by the Junior College

and the Technical Institute in our educational system.

I had the opportunity to attend the 3-week intensive course at Case Institute of Technology. The correct heading on some of the material which I have here is: "Process Control for Technical Institute Instructors." As the experts in the field of *instrumentation* know, many of the instrument manufacturers have very excellent hardware schools in their factories so, most of us thought it indeed a privilege to participate in the intensive program at Case and really appreciated the effort put forth by Dr. Irv. Lefkowitz and his staff.

I believe in giving credit where credit is due. You are right to the extent that it was an intensive course and three weeks in length. We were in class daily from 8:30 AM to 4:30 PM or later Monday thru Friday and until noon on Saturday. It was a very well planned program of lecture, analysis, supervised study and problem solving plus laboratory. Because I teach Industrial Instrumentation in a Junior College program, I was particularly interested in the way the theory and laboratory experiments were worked out. For example, one could make use of Nyquist criteria, Bode plots and the like and calculate the stability and controller settings (optimum) and then set them up on the analog computer and verify them. I also like the fact that they had sufficient hardware available in the lab, so that the lab groups usually contained just 2 or 3 and everyone had an opportunity to do every part of each experiment and sometimes try the same experiment on different brands of equipment. One more remark and then I'll leave this topic . . . I found the Case Institute program very worthwhile.

I do hope that the author of this editorial having gotten a lot off of his chest make an attempt to learn a bit more about the role of the scientist, the engineer, the technician and the mechanic and then resort to constructive criticism in the future.

Oliver K. Schaer
Longview, Wash.

There are now many courses emphasizing process dynamics, and the Case course is probably one of the best of these. Our point, however, is that the greatest problem is getting the least attention—this is the problem of upgrading the average physics course for the average high-school student. We used instrumentation to do this in Pittsburgh—and found opposition from academic purists due to the anti-hardware philosophy we documented.

RAMBLINGS ON INSTRUMENTATION

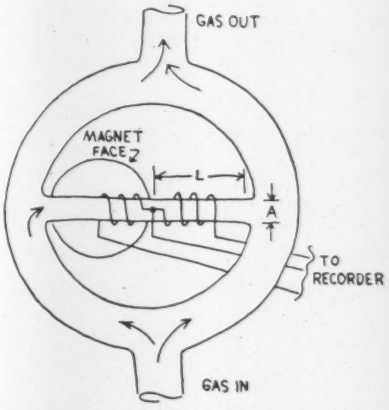
Confessions of an R&D Spy

While waiting nervously for one of the rare audiences granted by our Chief Engineer, our eyes lit on a memo stamped "TOP SECRET" lying on his desk. Feeling somewhat guilty, we scanned it. It began: "Chief, don't blab this to Sprague but . . ."

Feverishly, we read on. The gist of it was that good old R&D had succeeded in developing a new low range oxygen analyzer that meets some rather stringent specs we handed them a short while ago. Not only, we read, does the product meet the specs but it is *already in production!* (Our R&D Department takes a motherly attitude toward new products. When somebody buys one it's almost like having a son leave home. Hence the secrecy.)

Using private-eye methods, we succeeded in ferreting out further information of possible interest to customers. The specs of our new model 632 Analyzer, for instance:

Ranges: 0 to 1%, 0 to 2%, 0 to 3% O_2
Accuracy: ± 2% of Range
Zero Stability: ± 1% of Scale
Time Constant: 5 to 7 seconds
Hydrogen Insensitivity: To 50%



"Magnetic Wind" generated by presence of O_2 in sample produces flow of gas from left to right, cooling left hand and warming right hand windings.

The analyzer works on a new concept of a principle we've proved out for over a decade in our Standard Magno-therm O_2 Analyzer. That is, that oxygen—almost alone among common gases—is paramagnetic. By somehow measuring variations in the paramagnetic properties of a given volume of gas, our analyzer develops a highly accurate reading of its oxygen content. It measures like crazy even when changes are as miniscule as .01% O_2. And there are no moving parts to be oiled, greased, sharpened, ground, re-wound or degaussed.

The important characteristic of Hydrogen insensitivity can be easily explained, according to our Engineer, by this sketch of the analyzing cell coupled with the impressive formula:

$$Q = k \triangle T A \frac{I}{L}$$

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If your problem is getting an accurate measurement of king-sized quantities of oxygen, we can supply this analyzer calibrated for Suppressed Range O_2, operation, e.g. 98 to 100% or 18 to 21% O_2.

From the foregoing, any man with an oxygen measurement problem can easily deduce that the Hays Low Range and Suppressed Range O_2 Analyzers have features that beggar description. Our Chief Engineer has tentatively agreed to release the complete details to those prospective customers with proper credentials.

However, I suggest you write directly to me, with or without credentials. Having an intense fiscal involvement in the matter, I personally guarantee to send you either the information or the Chief Engineer himself, whichever appears more lucid.

Phil Sprague
President

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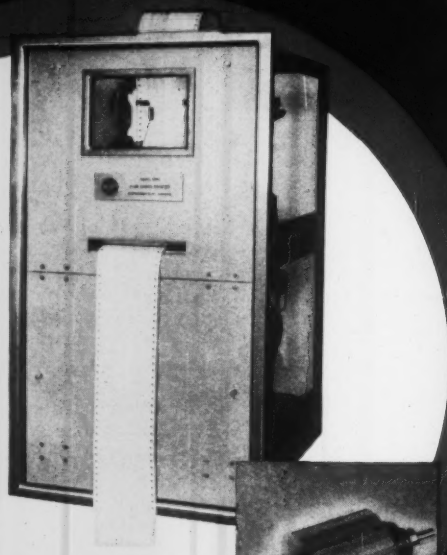

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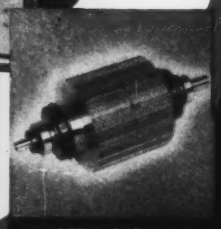

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LETTERS—CONTINUED

Editor, I&CS:

I am heartily in agreement with your editorial "Anti-hardwarism etc." in the March issue of your magazine.

I am reminded of the horror of the learned philosophers when Galileo questioned their "basic fact" that heavy objects fall faster than lighter objects. When he actually proposed an experiment to prove or disprove their "fact" they were ready to have him killed.

Science never made any progress until measurements became possible; and as such measurements became ever more precise, the theories had to be altered and revised to explain the deviations of the measurements from their expected values.

Your remarks on the relative quality of the teaching required in high schools compared with what *passes for teaching* in universities, are also very appropriate. Lectures can be either the finest or the poorest means of teaching. A good teacher can make a lecture really live *with proper demonstrations*. A poor teacher, even though the brightest theorist on earth, or the finest research scientist, will fail to put his subject across, chiefly because he cares so little about his students' needs.

The universities are full of poor teachers because of their insistence upon research ability rather than inspirational ability as the main criterion for advancement in status. If high-school teachers did as poor a teaching job as these men, there would be hardly any high-school graduates, to say nothing of applications for admission to college.

Some of the most stupid men I have ever met did very well in college or university because they remembered lectures so well, and were able to give the correct answers to their examination questions. Unfortunately they never were given problems to solve which would require a thorough understanding of their subjects.

Despite all this, a college education can be very rewarding because there are still many real teachers on the faculties of most colleges.

I was fortunate in attending Cleveland's East Technical High School before I entered Case Institute of Technology. I am sure I always had more assurance that I thoroughly understood theoretical principles because of the good basic courses I had in high school.

The experimental course in "Basic Physics" in Pittsburgh, described in your February issue, sounds most

praiseworthy. That it is not a "hardware course" is shown by the large proportion of students who have gone on to college. I feel sure that they will never be satisfied merely to memorize lectures.

My thirty-six years as a mechanical engineer with Westinghouse have been very pleasant, with great variety in design, invention, development and research mostly in the control of stream turbines. Control is perhaps the most general of the specialized fields of engineering.

Orzo N. Byrant
Large Turbine Engrg.
Westinghouse Electric Corp.
Philadelphia, Pa.

Editor, I&CS:

I would appreciate a copy of your editorial of March 1959 on Anti-Hardwarism. I understand you have had past articles on this subject. Your point of view is one we can appreciate.

John G. Sinclair, Jr.
President
Science Center
Los Angeles, Calif.

The Science Center is a Los Angeles scientific and cultural activity that includes a Young Peoples Science Exhibition, Career Hall, Career Caravan, Young Peoples Science Library, Material shop, Hobby hall, Public Science Information Agency, etc.

Editor, I&CS:

We find your editorial, "Report on Public High-School Course in Modern Physics", of interest.

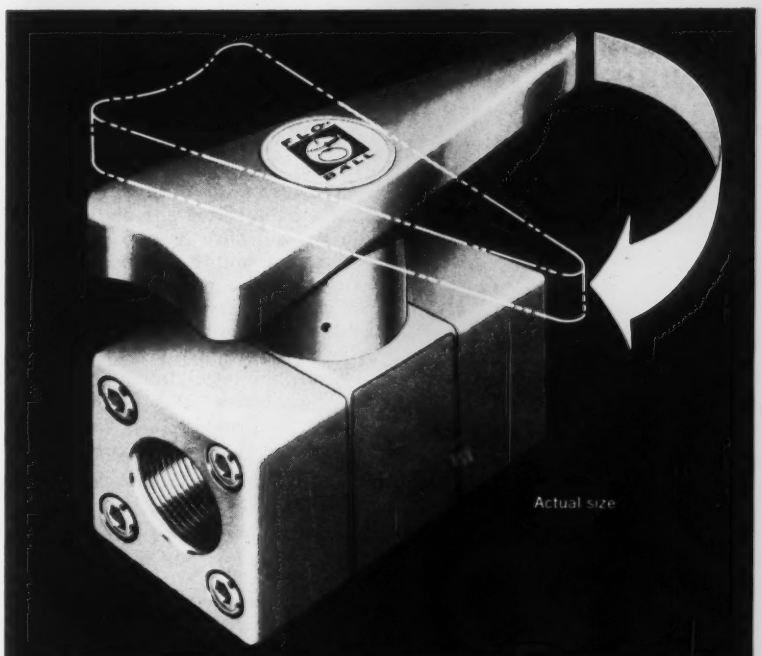
Would you forward to the writer's attention one reprint.

J. E. Casey
Technical Assistant to Manager
Leeds & Northrup Co.
Philadelphia 44, Penna.

Editor, I&CS:

I would like to obtain reprints of the article in Volume 32, Number 2 of *Instruments and Control Systems*, page 225, "Report on Public High School Course in Modern Engineering Physics." If reprints are available, we would like to have about fifty copies for distribution to academic and industrial scientists who may be interested in a similar program for this area.

S. W. Caywood, Jr.
Chairman, Education Committee
American Chemical Society
S. Jersey Section
Gibbstown, N. J.



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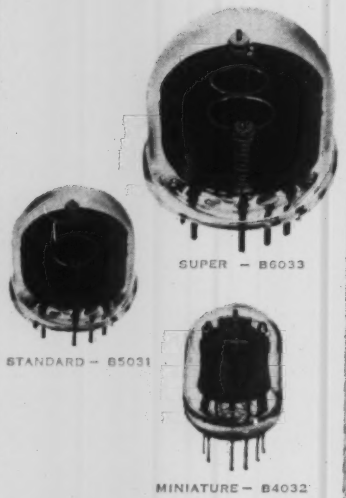

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LETTERS—CONTINUED

Editor, I&CS:

Hurrah for this good work! (School Program in Modern Engineering Physics) I could only wish there were more of it.

Returning from a trip to UNESCO in Paris, I have come back with the most profound thankfulness that our American Education is as good as it is, and that it is in the hands of dedicated, forward-thinking people. There is no question our education can be improved to the betterment of our nation and ultimately the world.

W. M. Welch
W. M. Welch Mfg. Co.
Chicago 10, *Ill.*

Editor, I&CS:

We should like to receive 1 copy of your publication: 1. "Report on Public High School Course in Modern Physics" 2. "A Threat to American Education and The Instrument Industry"

Your two editorials (or report and editorial) were most important.

I. C. Carter
American Cyanamid Company
Stamford, Connecticut

Editor, I&CS:

Your "Report on Public High School Course in Modern Engineering Physics" in the February issue was very interesting. Do you have reprints of this available? This office receives many inquiries for information regarding high school programs in modern physics and chemistry, and your article should be of great interest to many high school systems. If reprints are not available, I would appreciate your listing a few names of individuals who would be able and willing to describe the Pittsburgh program to others interested in science education in secondary schools.

George W. Courtney, Jr.
Atomic Energy Commission
Washington 25, *D. C.*

Editor, I&CS:

Please send me if available 10 copies of the editorial in March on Anti-Hardwarism. Most of these will be circulated in the New Canaan public school system where, in a small way, we have been doing what has been done in Pittsburgh.

If possible, also, please send me as much detail as possible (such as earlier data in *INSTRUMENTS*) so that we may follow in Pittsburgh's footsteps. Our schools adopted town-wide homogeneous grouping last year, and earlier had adopted a merit-pay system for teachers. If you can spare, say half a dozen copies of any material, they would be appreciated. Even rough notes in single copy will be helpful as it is *ideas* that count.

William Offenhauser
New Canaan, Connecticut

P. S. Near us are such firms as Perkin-Elmer, Cyanamid, Schlumberger, AMF, Teleregister, Sorensen, LIFE and TIME Research Labs, Norden, CBS Research, etc. They are all helpful in one way or another.

It is indeed ideas that count—plus men like Offenhauser to spread them and make them grow!

Editor, I&CS:

On page 175 of the February, 1959 issue of your magazine, a reader inquires about an Instrument Rental Service. (A-378)

The General Electric Company has recently announced a new Instrument Rental Service available thru its Service Shops or its Apparatus Sales Office. Brochure GEA-6829 describes this new facility.

K. K. LeGere
General Electric Company
Schenectady Instrumentation Service
Schenectady 5, *N. Y.*

Editor, I&CS:

I have endeavored through various sources to obtain the December 1958 and January 1959 issues of your magazine but to no avail. I was endeavoring to loan them in order to have your year-end reviews photostated.

Charles H. Lieder
5 *Po Lane Hicksville, N. Y.*

Many issues are in such demand that all copies have been exhausted.

Editor, I&CS:

Over the last several years I have followed your several articles on the use of instrumentation in teaching high school physics in Pittsburgh.

Your editorial on page 375 of the March, 1959, issue [Anti-Hardwarism] I found particularly stimulating.

W. B. McCormack
Wilmington, Del.

Editor, I&CS:

Recently I had the opportunity of reviewing an article entitled "Digital Automation" by Klein, Williams and Morgan which was published in Volume 29 of your publication. This article covers linear programming and would be very useful to me. I would appreciate two copies, one for my personal file and one to loan to graduate students working with me. Thank you.

L. L. Boyd
New York State College of Agric.
Cornell University
Ithaca, New York

This material is available in the book DIGITAL TECHNIQUES FOR COMPUTATION AND CONTROL, Klein, Morgan and Aronson, Instruments Publishing Company, $6, cloth-bound.

Editor, I&CS:

I would like to congratulate you on the series covering tape. I've heard a number of very favorable comments on the March issue and I'm sure they're being echoed throughout the industry. I'm advising our engineers of the subjects which you noted you will feature in forthcoming issues, and they're looking forward to seeing them.

Perry McClure
Ampex Corp.
Redwood City, Calif.

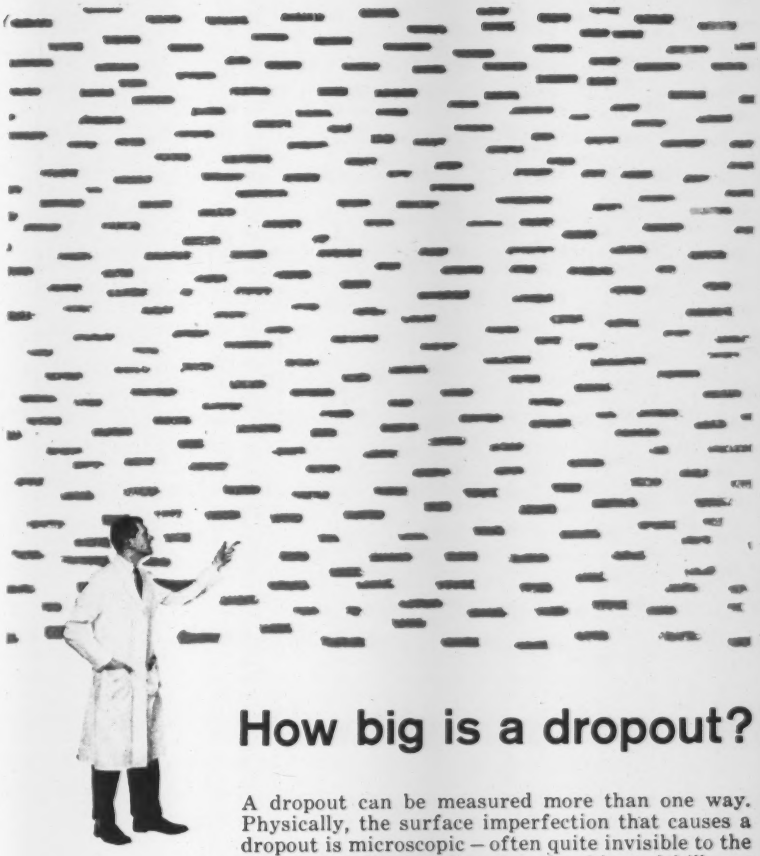
Editor, I&CS:

I can report some progress toward solution of my training problem . . . in another three years we will have arrived at the beginning of what you and I might consider a fully qualified instrument department, and in five years it should measure up to the best.

We have concluded arrangements to train 40 of our present "high grade fitters" under our Section Inst. Training Supervisors, giving each of them 3 hours class work per week and at least 6 hours per week "on the job instruction." As we train apprentices they will be replaced. We have a similar program in operation for 16 apprentices now, and will add another 14 in April.

Twenty of our lower level staff are attending evening classes in engineering at Abadan Institute of Technology (this operates under guidance from Lafayette College at Easton, Pa., and is staffed by qualified college level professors).

Six of our present fitter group who hold 12th class Iranian School cer-



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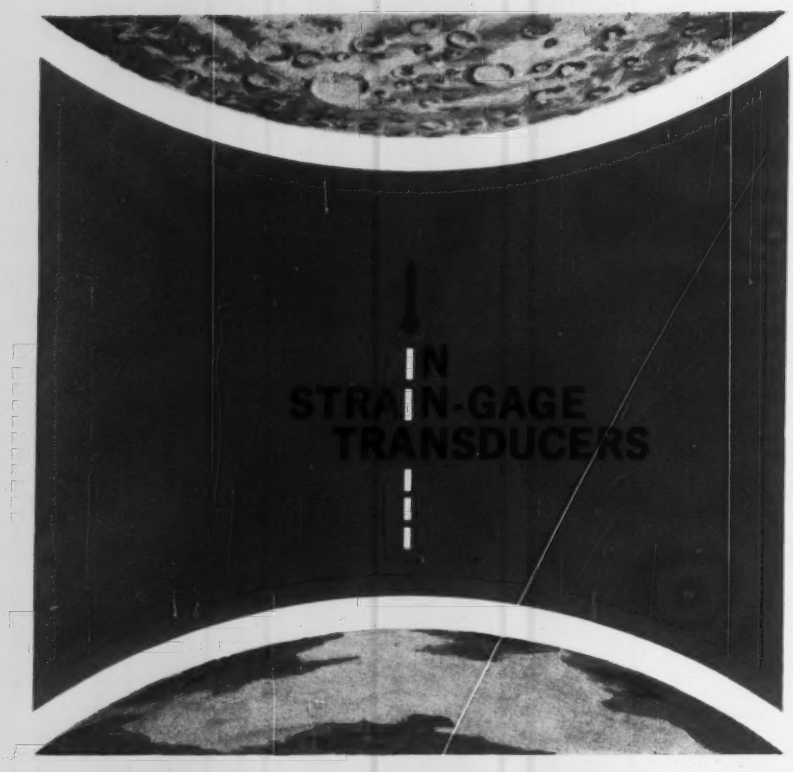

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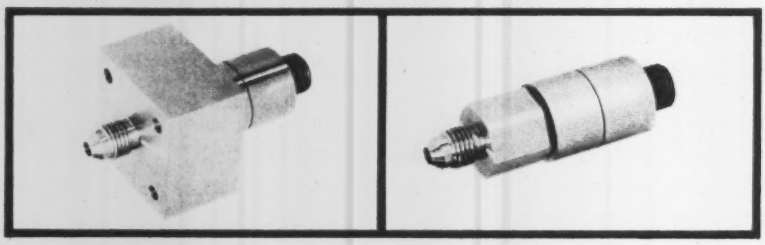

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LETTERS —CONTINUED

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Permit me to say "thanks" to the help you so kindly gave me last spring. Some of the information has helped guide these programs considerably. And you might be interested to know that your last issue of *Instruments & Control Systems* finally caught up with me last night.

I keep an index on all file magazines covering subjects we may require reference on at a future date. Seven of your articles made my "index list" from one issue. I believe that's the jack-pot for any monthly.

So, I remain—yours for many more good issues,

John W. Ohler
Iranian Oil Refining Co.
Abadan, Iran

The largest instrument department in the world is not in the United States, not in Russia—but in Iran. In the largest refinery in the world which is located in Abadan, on the Persian Gulf, you might expect to find the largest array of instrumentation—40,000 in all. Most instruments are American made, although a good portion is "made in England." The man in charge of instrumentation is an American: John W. Ohler.

Editor, I&CS:

I just read the reprint of your February editorial. Congratulations!

It sounds as if your course was a great success. I would appreciate it if you would send me a half dozen reprints.

James Stern
Int'l Representative
National Aircraft Department, UAW
Detroit, Mich.

reader inquiries

Moisture in Tobacco

Technical information service of large manufacturing concern seeks indicator of moisture in tobacco moving on conveyor belt at approximate speed of 240 ft/min in 3"-to-4"-thick layer. Range: 11 to 14%. A-409

Endless-Tape Recorder

Manufacturer of cosmetics seeks endless-tape recorder and cartridges. A-408

Long Pins

Professor at Junior College seeks "long, thin, pointed pins on which numbers could be inscribed or written on the head and would be large enough to observe with the unaided eye." Use: practical examinations in anatomy. A-407

Density of Tile

Plant engineer for manufacturers of clay floor tile seeks instrument that can determine density of dry-pressed tile. A-406

Glass Marking Pencil

Distributor of vacuum tubes seeks pen or pencil for heat-resistant marking of vacuum tubes. A-405

Indicator for Efficiency of Machine Operation

Technical information department of large manufacturing concern seeks indicator which attached to a machine can display ratio of machine's operation time to the elapsed time of working day. A-404

Infrared CO Gas Analyzer

Importer in Japan seeks infrared CO gas analyzer. A-403

Meat Probes

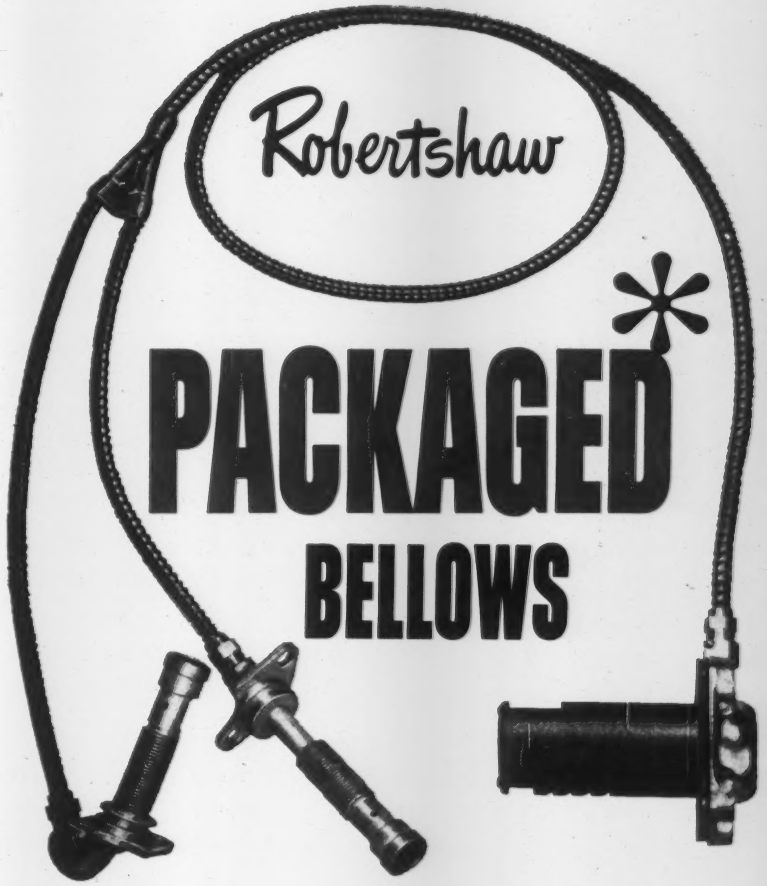
Assistant purchasing agent of Canadian heater manufacturer seeks meat probes with an on-off temperature regulator coupled to a remote adjustable indicator to control the electric elements on the oven of a domestic electric range. A-402

Ball Bearings With Synthetic Race

West-German manufacturer seeks high-speed ball bearings of miniature size with outer race made of synthetics. A-401

Flat Gage Glass

Head of College Mechanical Engineering Dept. seeks source that can supply flat glass for steam pressure gages. A-400



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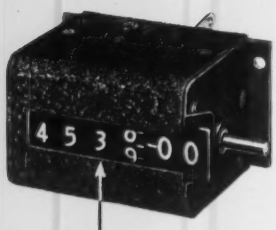

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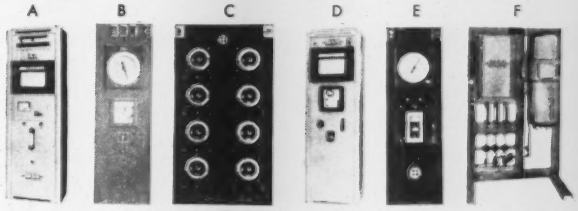

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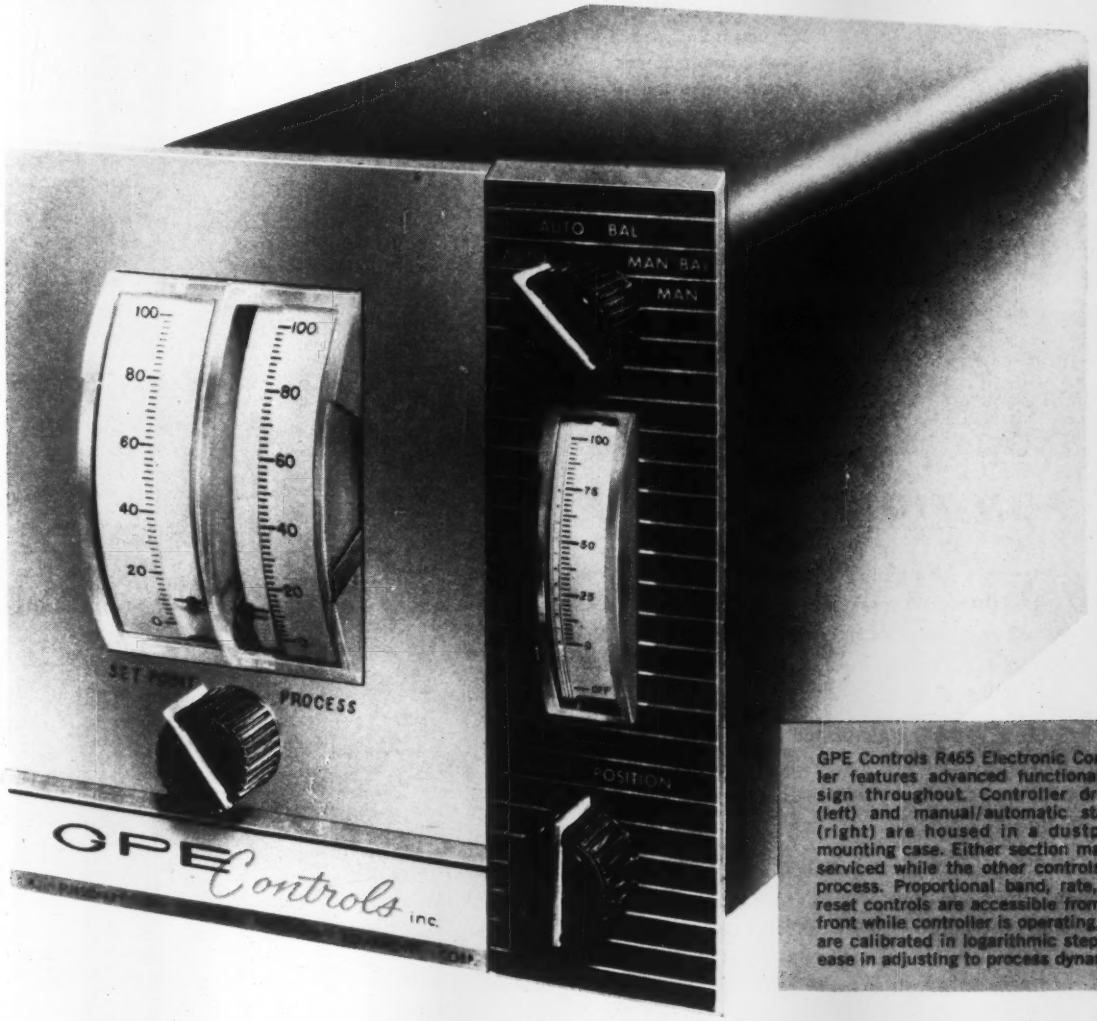

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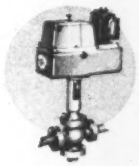

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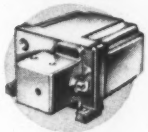

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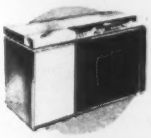

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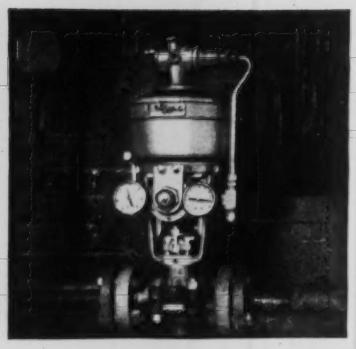
Designed expressly for industrial automatic control applications. Simple, proved, moderately priced.

For more information circle **17** on inquiry card.



"Best valves we ever found for tight shutoff on our maleic acid lines" says Instrument Foreman of a well-known mid-west chemical plant.

YOU CAN COUNT ON

CONOFLOW

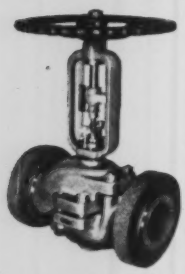
LB CONTROL VALVES

FOR TIGHT SHUTOFF

Major chemical companies have switched to Conoflow Series LB Control Valves because they provide absolute tight shutoff, regardless of operating variables. Tight shutoff prevents waste of costly liquids and gases . . . insures precise process control.

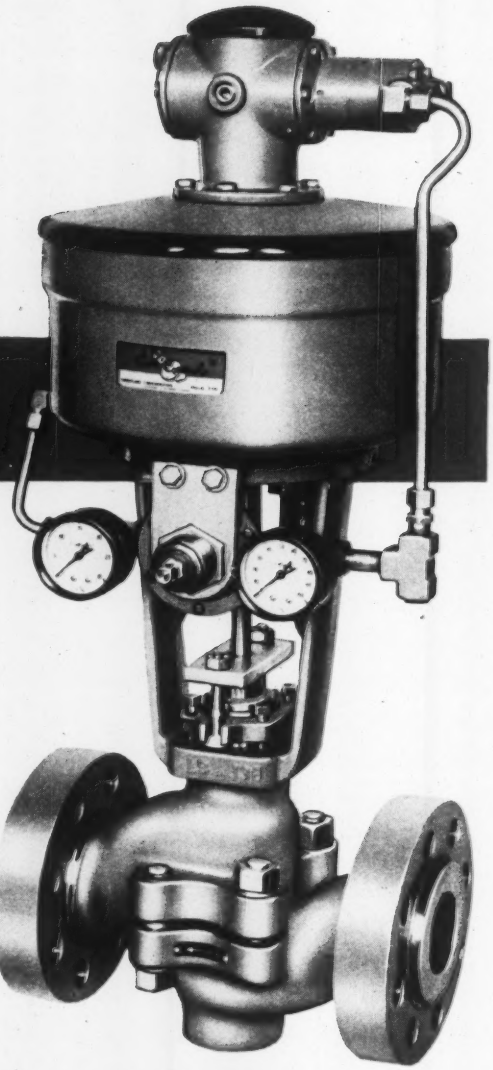
The answer is the single-seated body and the powerful cylinder actuator of the LB Valve. This integrated body-actuator design allows for leak-proof shutoff not possible with double-seated valves.

An added feature of the LB Valve is much lower all-around maintenance costs. Body separates easily at seat ring for tear down and inspection. Fewer replacement parts mean substantial inventory savings. Streamlined body contours and extra thick walls assure longer life in corrosive and erosive services. Also, when it comes to special alloys . . . type 316 Stainless steel, Hastelloys, Monel, Nickel, Everdur, etc., the single-seated LB Valve offers a substantial initial cost advantage over double-seated construction. By all standards, your overall cost is much less for a Conoflow Series LB Valve.

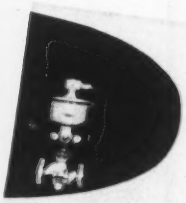


Also available with sturdy handwheel actuators for precise manual control.

If you are not already a user, try a Conoflow LB Control Valve . . . and let it prove itself.



Phone your nearest Conoflow representative (located in principal cities), or write to Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. for Bulletin LB-3-1A



CONOFLOW CONTROL VALVES

Cono Controls®

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

SUBSIDIARY OF WALWORTH

For more information circle **18** on inquiry card.

trends

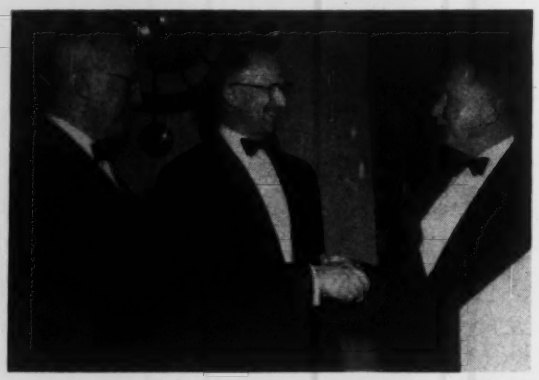
Report of the executive vice president and secretary, SAMA, at White Sulphur Springs, West Virginia, 41st annual meeting: The Laboratory Apparatus Section, SAMA, showed a 5% gain in 1958 as compared with 1957, and during the first two months of this year their sales were up 9%; The Laboratory Equipment Section showed a gain of 28% during 1958, and in January and February of this year they were running 7% ahead of 1958; The Industrial Instrument Section was up 32% last year, and during January and February of this year continued to show approximately the same rate of gain; The Optical Section reported an increase of 5% in sales last year, and this year sales were up 11%; The outlook for the remainder of 1959 is for continued improvement.

BDSA, Dept. of Commerce, recapitulation of the 1954 sales of optical instruments (in 000's of dollars):

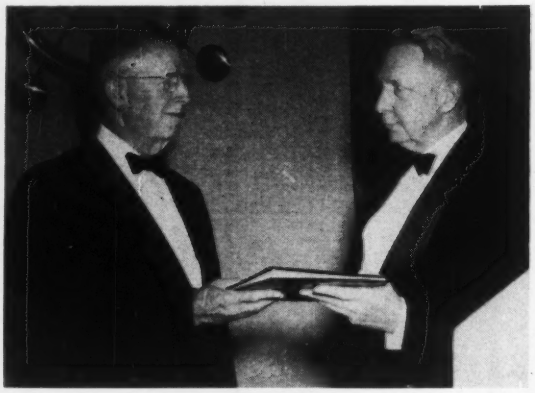
Finished Optics-Mounted and Unmounted (except projection and photographic lenses) ...	$9,343
Magnifiers and Reading Glasses—including industrial magnifiers and loupes	740
Binoculars, Telescopes, Rifle Sights, Field Glasses, Opera Glasses, etc.	10,190
Microscopes and Accessories—including laboratory, students', stereoscopic, toolmakers', traveling, shop, etc.	9,183
Photomicrographic Equipment	900
Optical Process and Quality Control Instruments —comparators, optical gauges, polariscopes, refractometers, and similar instruments used for measuring and gauging materials in process; and for examination and inspection of finished and semifinished parts ..	3,978
Spectrographic and Spectrometric Equipment— including spectrophotometers, monochrometers, etc.	8,900
Metallographic Equipment and Accessories ...	438
Mapping, Navigational, Surveying, Meteorological and Geophysical Equipment—including photogrammetric mapping equipment ..	4,618
Ophthalmic Instruments—including hand diagnostic and refractive instruments, orthoptic and other visual training equipment, etc.	4,244
Medical Internal Examining Instruments— endoscopes, cystoscopes, gastroscopes, etc.	2,257
Projection Apparatus—including slide projectors, microprojectors, cinema projectors, etc.	52,621
Photographic Lenses—still, motion picture and special purpose camera and accessory lenses	49,084
Other Optical Instruments of a Specialized nature—including military optical devices such as bomb-sights, fire control instruments, periscopes, etc., not elsewhere reported	94,268
Total Sales of Optical Instruments and Apparatus	$250,764

news

Downsbrough Elected SAMA President



Newly-elected SAMA president Dr. George A. Downsbrough (center) is congratulated by Richard E. Welch, retiring president. T. M. Mints, treasurer, looks on.



Lewis B. Swift receives SAMA award from Richard E. Welch.

The Annual Banquet was a highlight of the 41st Annual SAMA meeting.

WHITE SULPHUR SPRINGS, W. VA.—The Scientific Apparatus Makers Association met for its 41st annual meeting April 25-30 at the Greenbrier Hotel to listen to reports of its five sections, and to distinguished speakers; hold elections; discuss business trends; and to honor an outstanding leader in the scientific instrument industry by an award.

Approximately 300 members attended and heard Executive V. P. Ken Andersen report section gains for 1958 between 5% and 32%, and a strong upswing in general business conditions which is carrying the instrument industry along with it.

Dr. Allen V. Astin, director of the National Bureau of Standards, warned that Soviet Russia was leading this country and the entire world in high-temperature development, of vital importance to the rocket and missile program; and in instrument calibration—the process of verifying measuring instruments. Dr. Astin pointed to the relative position of Russia and the U. S. several years hence if these problems are not solved speedily.

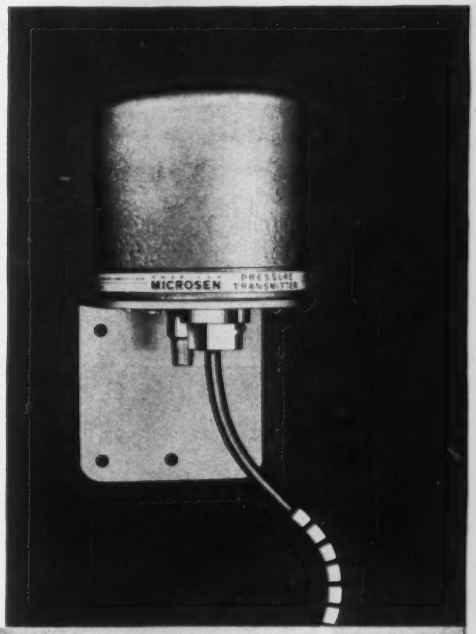
Voting resulted in election of Dr. George A. Downsbrough, 49, president and general manager of Boonton Radio Corp., as president of SAMA; with R. G. Halvorsen, executive vice president of Hamilton Mfg. Co., being elected president pro tempore. T. M. Mints, president of E. H. Sargent & Co., continues as SAMA treasurer; while the following members will serve as chairmen of the five sections: W. Noel Eldred, vice president of marketing, Hewlett-Packard Co.: *Industrial Instrument* section; B. R. Fisher, vice president, Fisher Scientific Co.: *Laboratory Apparatus* section; J. J. Host, general sales manager, American Optical Co.: *Optical* section; Erik L. Sjostrom, president, John E. Sjostrom Co.: *Laboratory Equipment* section; and P. S. Dickey, president, Bailey Meter Co.: *Recorder-Controller* section.

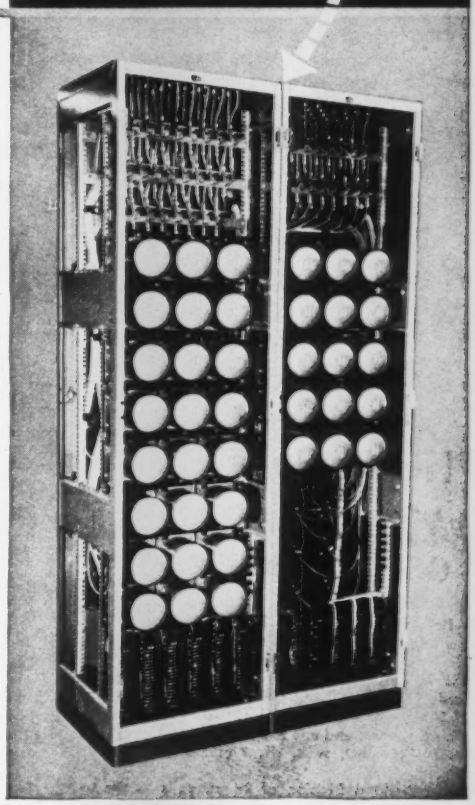
Directors-at-large include Philadelphians Henry F. Dever, president, Brown Instrument Div., Minneapolis-Honeywell Regulator Co.; Edward B. Patterson, president and treasurer, Arthur H. Thomas Co.; and I. Melville Stein, president, Leeds & Northrup Co. A. W. Fisher, president, Fisher Scientific Co., Pittsburgh, and R. G. Halvorsen complete the list of Board members.

The coveted SAMA Award went to Lewis B. Swift, chairman of the board of directors, Taylor Instrument Cos. The 74-year old recipient was cited as a man whose accomplishments in the scientific instrument industry placed him among the nation's leaders for his outstanding record of achievement and contribution in the best interests of his country, the industry and his home community.

NOW... a compact ELECTRO-PNEUMATIC PRESSURE TRANSDUCER

for data reduction systems





The American-Microsen® Series 185 Pressure Transducer is designed to convert pressure signals to dc signals for use with data handling, telemetering or computer equipment. It can be supplied with input ranges from 0-15 psi up to 0-1000 psi; also 3-15 psi to transduce pneumatic signals.

The Series 185 Pressure Transducer converts pressure signals to 1.0 to 5.0 ma. dc which is readily accepted by data handling systems. Sensitivity of the unit is practically infinite. It has a repeatability of 0.3% of span; speed of response is 10 cps.

Use of the Microsen Balance enables the transducer to transmit signals instantaneously over long distances. An external power supply is employed which can be filtered to provide a high signal-to-noise ratio as required in high speed data handling equipment.

Housed in a dust and weatherproof case for universal mounting, the Series 185 Pressure Transducer can be installed on a vertical surface, pipe pedestal or meter piping. It is also readily adaptable to rack mounting as shown at the right. Get detailed information. *Write for Bulletin TP515.*

MANNING MAXWELL & MOORE INC. TRADE MARK

MICROSEN ELECTRONIC CONTROLS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **15** on inquiry card.

Open Hearth Gets Automatic Combustion Control

PHILADELPHIA, PA.—Leeds & Northrup has installed instrumentation on the No. 17 open hearth of the Colorado Fuel and Iron Corp.'s Pueblo Plant by which the operator can "dial-in" (1) combustion input to the furnace, including maximum Btu for protection against overfiring; (2) fuel-air ratio, for effective combustion; (3) steam-oil ratio, for desired flame characteristics; and (4) oil-gas ratio, for economical use of available fuel.

After requirements have been determined, these values are automatically controlled to maintain furnace operation, regardless of whether oil, gas, or mixtures are being fired. Roof refractory damage is prevented by a controller that automatically cuts back Btu input to prevent overheating.

By constantly improving techniques, CF&I has grown to its present position as the nation's ninth largest maker of steel products, and the West's biggest integrated steel plant.

Gas Chromatograph Aids in Smog Study

PASADENA, CALIF.—Stanford Research Institute, under sponsorship of the Air Pollution Foundation, is currently conducting smog studies with the aid of three Loe Engineering Chromat-O-Flex gas chromatographs connected in series. Chief offendants are automobile exhaust gases which are traced in the part-per-billion range by thermistor detector elements. A simple trapout technique is used to concentrate the trace components.

FISHER GOVERNOR CO. has produced a 16-mm colored film "Muscles of Control" which shows the engineering and function of control valves and actuators.

NATIONAL MERIT SCHOLARSHIP CORP. has announced the winners of the nation's largest scholarship competition with the naming of 850 high-school seniors as the Merit Scholars of 1959. 750 teen-agers will share, along with their colleges, in more than $3.5 million in scholarship assistance. Another 100 seniors received honorary awards.

LIBRASCOPE has set a new record in computer manufacturing by shipping one major installation per day in the month of March.

Simplatrol ELECTRIC CLUTCHES & BRAKES

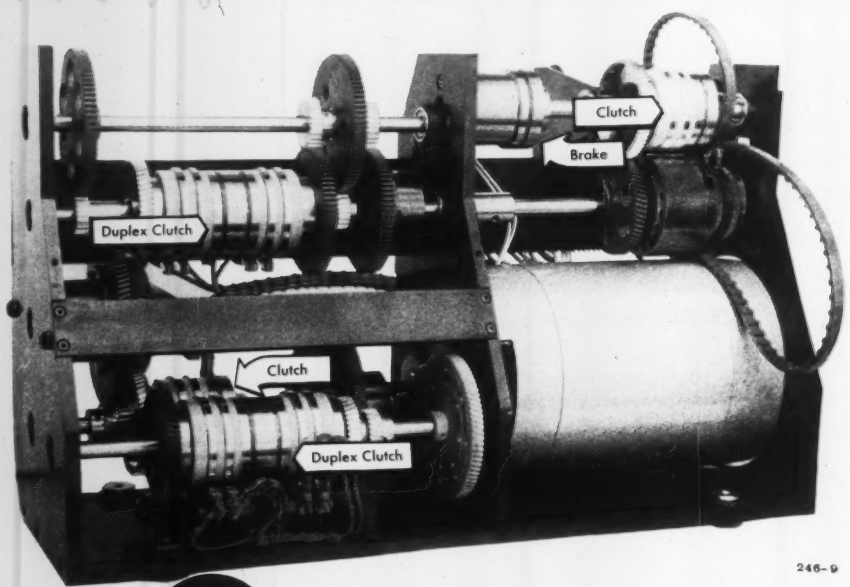
...In New
HONEYWELL
VISICORDER®
OSCILLOGRAPH

Here you see a classic illustration of the adaptability and versatility of Simplatrol Electric Clutches and Brakes. In this new Honeywell Model 1012 Visicorder Recording Oscillograph two sets of Simplatrol Duplex clutches, two Simplatrol clutches and one Simplatrol brake form a compact, swift, silent and sure "team".

The Heiland Division of Minneapolis Honeywell has set an extremely high standard of speed and accuracy for this clutch and brake installation. Simplatrol has met the challenge.

In Simplatrol electric clutches the patented diaphragm makes the difference . . . it's the only moving part in the Simplatrol clutch and brake.

Ask for special Simplatrol literature on large, miniature and small and fixed field clutches and brakes.



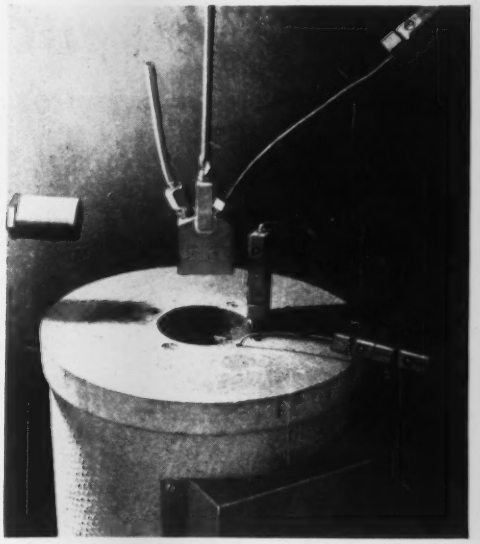
246-9

Simplatrol products corp.
24-8 SALISBURY ST., WORCESTER, MASS.
Representation in Key Industrial Areas

For more information circle 20 on inquiry card.

Ceramo® Thermocouples "Tortured" By Exotic Fuel Explosions At Air Reduction Co.

Metal "bomb" designed by Airco for testing liquid fuels showing "Ceramo-Couple" and gas escape line.



Airco furnace containing molten metal—with test "bomb" ready for immersion.

When Thermo Electric designed "Ceramo" for extra-tough thermocouple applications, even "Ceramo's" designers did not figure on the "torture test" devised for it by Air Reduction Co. High temperatures, extreme corrosion, high pressure, great durability, easier installation—all these conditions "Ceramo" takes in stride with typical versatility. But ability to withstand actual explosions—well, that was a lot to ask. "Ceramo," however, did just that.

Airco needed such a thermocouple to test thermal stability of rocket and jet engine liquid propellants at their Murray Hill, N. J., laboratories. The fuel is placed in a small metal vessel which is then immersed in molten metal. One opening of the vessel is sealed with a small rupture disc. In the other opening a thermocouple is fitted to measure the reaction rate of the fuel over a wide range of temperatures before explosion occurs. Naturally, the thermocouple must withstand the explosion. "Ceramo-Couples" withstand 10 or more such explosions before replacement. This "torture test" is endured by enclosed junction "Ceramo-Couples" of but 1/16" o.d. with 30 gage conductors. This test method would not be feasible without thermocouples of such small diameters.

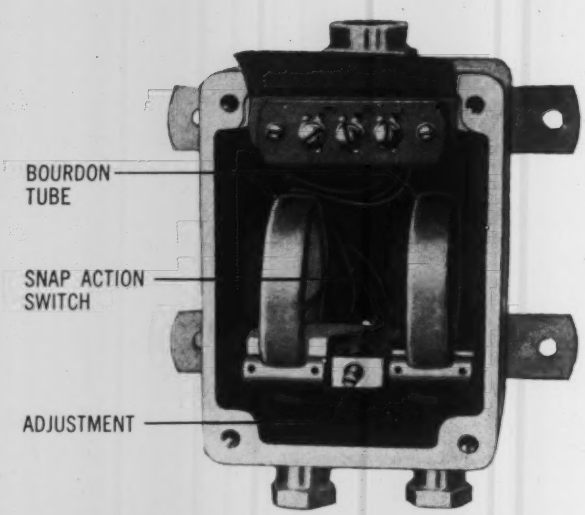
Other "Ceramo" features essential to this job include accuracy—to indicate exact temperatures; sensitivity—to indicate temperature changes quickly; and corrosion resistance—these exotic fuels are highly corrosive.

"Ceramo" could well be the answer to your thermocouple problems—mechanical, thermal or chemical. Find out by contacting Thermo Electric today.

Write For Bulletin 325-F

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ontario

For more information circle **21** on inquiry card.



INSTRUMENT QUALITY DIFFERENTIAL SWITCH

Senses pressure differences from 4 p.s.i. to 9000 p.s.i.

Proof Pressures ranging from 500 to 12,000 p.s.i.

A good illustration of this switch function is its application on multiple stage compressors. If a failure occurs in one of the stages the switch will signal the pressure difference change or shut down the system to prevent damage.

EXTREMELY ACCURATE

Simplicity of direct acting design plus rugged precision construction make for long, unchanging repeat accuracy.

Note, that we don't use

LINKAGES AND BEARINGS which, as they wear, cause settings to drift.

IN ANY POSITION

on moving equipment, even under vibration, switch performs with equal efficiency.

Because we don't use

LIQUID SWITCH ELEMENTS which require that the pressure switch be mounted absolutely vertical, which make it critical to vibration.

ASK FOR NEW CATALOG 9-PS FREE

PRESSURE SWITCH DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

For more information circle **22** on inquiry card.

stock report

Further information may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

AMERICAN STOCK EXCHANGE
PRICE RANGE 1959 THRU April 14, 1959

	HIGH	LOW	PRICE AS OF 5/14/59
American Meter	45 1/4	38	43 1/2
Arc Equipment	29 3/4	22 1/8	25 1/4
Barry Controls "B"	26	13 3/4	19 1/2
Belock Instruments	22 7/8	10 3/8	20
Benrus Watch	9	5 7/8	7 1/2
Breeze Corp.	9 3/8	6 1/4	7 1/4
Clark Controller	29 3/4	19 5/8	26
Clarostat Mfg.	10 1/4	4	8 3/4
Clary Corp.	10 7/8	5 3/4	9 1/2
DuMont Laboratories	9 7/8	6	9 3/8
Dynamics Corp. of America	12 3/4	4 5/8	11 3/8
Electronics Corp. of America	16 7/8	9 1/2	13 7/8
El-Tronics	2 1/4	1	1 1/2
Fairchild Camera & Instrument	138 7/8	50 3/4	130
General Transistor	88 1/4	49	75
Globe-Union	25 1/2	20 1/4	24 1/4
Hazeltine Corp.	75	54 1/2	70 1/2
International Resistance	22 3/4	7	17 1/2
Lear Inc.	19 1/4	9 1/8	15 1/2
National Research	39 1/2	15 3/8	36 3/8
New Haven Clock	5 3/8	1 1/2	3 1/2
Nuclear Corp. of America	4 1/4	1 3/4	2 7/8
Philips Electronics, Inc.	48 3/4	23 1/2	42 1/2
Pneumatic Scale	67	32	56 1/4
Servo Corp. of America	43 1/2	14 5/8	33
Servomechanisms	14 1/4	9	14 3/4
Statham Instruments Inc.	42	23	33
Victoreen Instrument Co.	19 7/8	6 7/8	18 1/2
Wallace & Tiernan	47 5/8	36 1/4	46
Waltham Prec. Instrument Co.	4 3/8	1 1/8	3 1/4

NEW YORK STOCK EXCHANGE
PRICE RANGE FOR 1959 THRU May 14, 1959

	HIGH	LOW	PRICE AS OF 5/14/59
ACF Industries	56 1/4	47 5/8	53 1/4
Aeroquip Corp.	33 7/8	23 5/8	31 3/4
Allis Chalmers	31 1/2	26 7/8	30 7/8
American Chain & Cable	57 1/2	47 3/4	55 1/2-55 3/4 (1
American Machine & Foundry	89 1/2	53 1/2	83 1/4
American Machine & Metals	59 3/4	41	52 3/8-52 7/8 (1
American Optical	49 1/2	38 3/8	47 1/4
American Tel. & Tel.	265 1/2	224 5/8	245
Ampex Corp.	84 1/2	67 3/4	70 1/4
Bausch & Lomb Optical	35 3/8	27	31 7/8
Beckman Instruments	79 3/4	36 1/4	64 1/8
Bell &Howell	73	58 1/2	64 1/2
Bendix Aviation	88	66	88 1/2
Boeing Airplane	46 1/2	37 3/4	39 5/8
Bullard	20 3/4	16	18 3/4
Bulova Watch	20 5/8	13 1/2	17 3/8
Burroughs	45 3/4	36 1/4	38 7/8
Carborundum	47	37 3/8	46 1/8
Cincinnati Milling Machine	46 1/2	38 3/4	44 1/2
Clevite	38 7/8	24 3/4	36 1/2
Columbia Broadcasting System	48 3/8	35	47 5/8
Consolidated Electrodynamics	42 5/8	33 3/4	38
Consolidated Electronics	46 7/8	33 1/2	42 5/8
Cornell Dubilier	29 1/4	20 3/4	27
Corning Glass	129	89 3/4	127 7/8
Curtiss Wright	39 1/2	27 1/8	36
Cutler-Hammer	91 3/4	59 1/2	88
Daystrom	49 3/4	34	48 1/4
Douglas Aircraft	57	50 1/8	56
Eastman Kodak	91 1/4	75	84 1/4
Eaton Mfg.	72	56 1/4	69 3/4
Electric Auto-Lite	47 5/8	36 1/4	47 1/2
Elgin Watch	14	9 3/4	12
Emerson Electric	69 7/8	48 1/8	67 1/2
Food Machinery & Chemical	49 3/4	40	47
Gamewell	39 1/4	27 1/2	29 3/4
Garrett	47 3/8	38	45 1/4
General Controls	39 1/4	24	36 3/4
General Dynamics	66 1/2	56 1/2	60 1/2
General Electric	84 3/4	74 5/8	81 7/8
General Instrument	38 1/8	16 1/2	33 5/8
General Mills	111 1/4	88 1/4	108-109 (1
General Precision Equipment	45 1/2	31 1/2	42 3/8
General Railway Signal	39 1/4	33	36 7/8-37 1/4
General Tel. & Elec.	73 3/4	60	70 7/8
General Time	102	35	90
General Tire & Rubber	83	44 1/8	75 5/8
International Bus. Machines	603	494	580 3/4
International Tel. & Tel.	45 1/2	28	42 1/4
ITE Circuit Breaker	50 1/2	36 5/8	45 3/4
Litton Industries	123 7/8	72 5/8	110
Lockheed Aircraft	39 3/4	28 5/8	33 1/2
Magnavox	70	48 1/4	63 1/4
Mallory	48 3/4	36 3/8	46 1/2
Minneapolis-Honeywell	137 1/2	111 1/2	134 1/2
Minnesota Mining & Mfg.	151 1/2	111 1/2	143 3/4
Motorola	130	57 1/2	111 1/2
National Acme	63 1/2	52 1/4	60 1/2
National Cash Register	80	66 1/4	69 1/8
Neptune Meter	39 5/8	32 3/4	33 5/8
North American Aviation	52 5/8	39 1/4	50 1/8
Northrop Aircraft	44 3/4	31 1/4	42 1/8
Otis Elevator	75 1/4	61 1/2	72 5/8
Philco Corp.	36 3/4	21	33 3/4
Radio Corp. of America	71	43 1/8	67 5/8
Raytheon Mfg.	73 7/8	56 1/2	66 1/2
Reliance Electric	60 3/4	42 5/8	57 1/2
Rheem Mfg.	25 5/8	18	24 3/4

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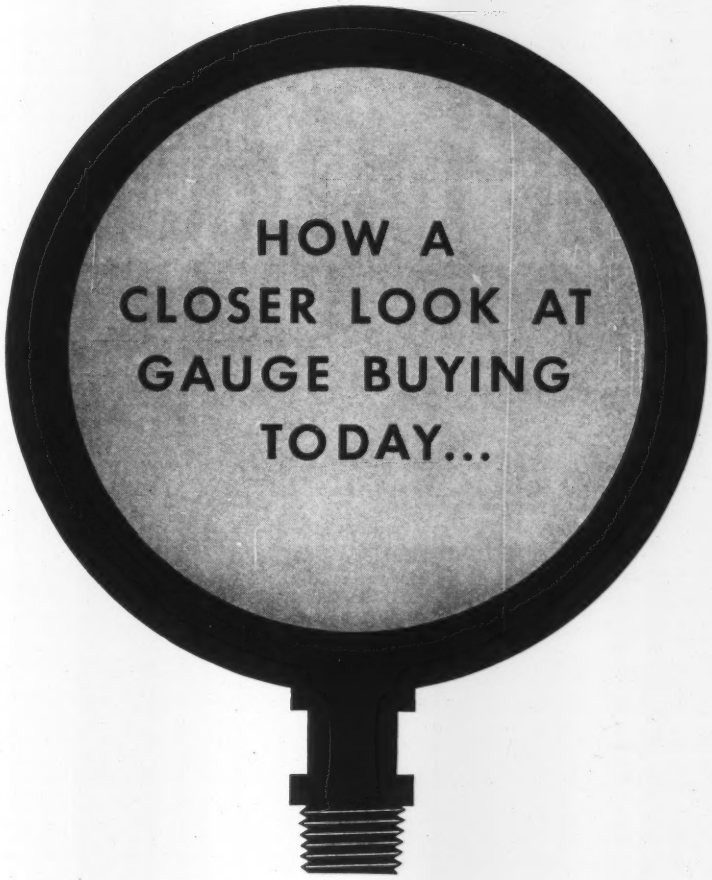
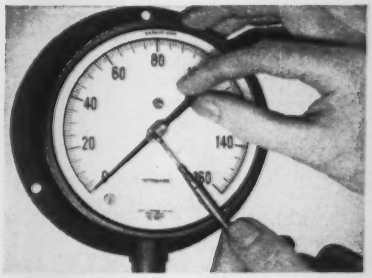


can help cut your gauge maintenance costs

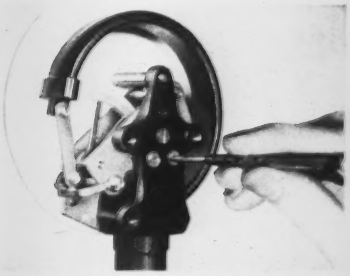
Been taking gauges pretty much for granted? As to the price you pay, accuracy you buy, performance you get . . . gauges you use and their maintenance costs? Maybe it's time for a closer look at the United States Gauge line and how it can streamline buying. USG features the most comprehensive line of indicating dial pressure gauges you can draw on . . . in range of case styles, materials and sizes, in pressure ranges and in price . . . up to the finest gauges money can buy. The *completeness* of the USG line can help you avoid over-buying, under-buying, help you get exactly the gauge performance you pay for . . . from one source! As shown at right, exclusive USG design features even help cut maintenance costs. Check your USG distributor for your next gauge requirement. See the Yellow Pages, or write for catalogs and name of your nearest USG distributor, today.

UNITED STATES GAUGE
Division of American Machine and Metals, Inc., Sellersville, Pa.



NOTE that with a USG Supergauge®, complete recalibrations can be made faster than with any other process gauge. For example: "zero shift" adjustments are made from the front with gauge in operating position, and without removing pointer from the shaft.

NOTE that with USG Mono-Unit design, internals are in one assembly which lifts out intact. Legend on dial gives full information for instant identification of model number and materials in components. More maintenance minutes saved!

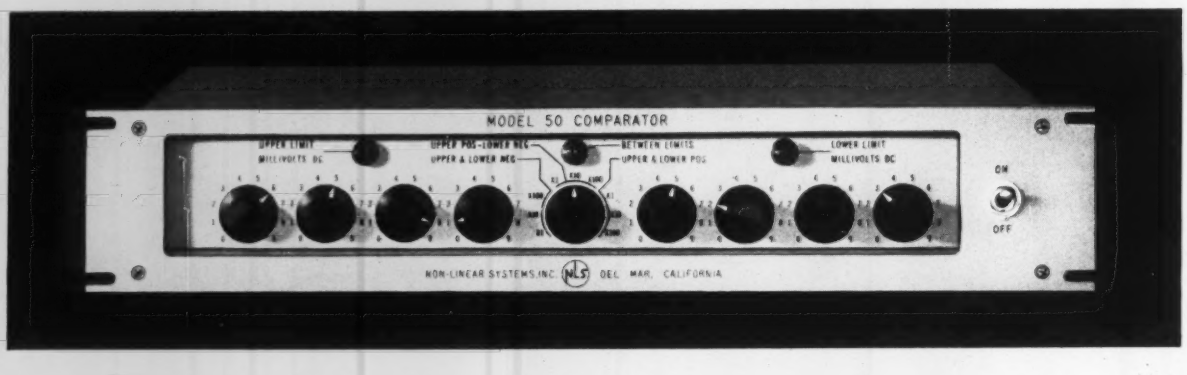


NOTE that with USG Arc-Loc® movement, corrections for "scale shape" (linearity) errors and "range" adjustments are both made from the rear; no need to remove pointer and dial. USG's unique locking method eliminates creep during locking, saves more time! USG Supergauges meet A.S.A. standards for Grade AA Test Gauges, including accuracy to ½ of 1%. *Write for Catalog 1819.*

SAVINGS IN USG A-LINE, TOO!
Premium gauge construction at savings up to 40% of premium prices! Major economies in pressure measurement where you may now be buying more gauge than you need! Meets A.S.A. Grade A standards, including accuracy of 1%. Wide choice of options. Has Supergauge Mono-Unit design — cuts recalibration time. *Write for Catalog 305.*

For more information circle **23** on inquiry card.

INSTANT INDICATION OF VOLTAGE TOLERANCE



with the NLS 50 Go/No-Go Voltage Comparator

Here's a new method for determining whether or not an input voltage is within prescribed limits . . . and to do so quickly, easily and accurately! Just set the front panel dials of the NLS 50 Voltage Comparator to read any two voltages within the range of ± 0.001 to ± 999.9 volts. Apply the voltage under test and in 90 milliseconds the NLS 50 gives a clear go/no-go indication of voltage tolerance. Watch the limit lamps on the front panel. If the green "Between Limits" lamp lights, the applied voltage lies within the pre-set limits. If either of the red lamps light — "Upper Limit" or "Lower Limit"—the voltage under test is too high or too low.

With a sensitivity of 0.005% and its limit settings precise to ± 0.01%, the NLS 50 Voltage Comparator outperforms any other type of voltage limit detector. It's transistorized, too . . . for reliability and ruggedness. And it's so compact . . . the only limit detector complete in one package. Comparison amplifier, limit setters, reference supplies and range multiplier are all included in the one instrument, a 3½-in. high unit that fits conveniently into a standard 19-in. rack.

In addition to giving visual warning to the operator, the NLS 50 gives go/no-go commands to such electrical devices as cut-off relays, sorting chutes, data printers, tape or card punches, and audible warning equipment. Extremely versatile, the instrument may be used as a high-accuracy voltmeter without modification and may be adapted easily to detect resistance limits.

The broad applications of the NLS 50 Voltage Comparator include the following:

- Automatic checkout of missiles and electronic systems.
- High-speed, high-accuracy warning systems involving any parameter that can be converted to voltage (speed, temperature, liquid level, distance, angle, acceleration, magnetism, weight, pressure, flow, light or other radiation flux).
- Automatic component test equipment for testing resistors, relays, diodes, transistors, vacuum tubes, batteries, tachometers, motors, speed regulators and slip rings.
- Automatic process control, receiving inspection, production quality control.

Write today for more detailed information concerning the capabilities, applications and operation of the new NLS 50 Go/No-Go Voltage Comparator.

PRICE $1775.00 COMPLETE • F.O.B. DEL MAR

Originators of the Digital Voltmeter

non-linear systems, inc.

DEL MAR (San Diego), CALIFORNIA

NLS — Digital Instruments That Work . . . And Work . . . And Work!

For more information circle **24** on inquiry card.

New York Stock Exchange: *Continued from page 818*

Robertshaw Fulton	47 1/4	31 5/8	40 1/8
Royal McBee	24 3/8	18	18 1/4
Sangamo Electric	51 1/2	35	49
Siegler Corp.	45 1/8	26 1/2	38 3/4
Sperry Rand	27 1/4	21 1/4	26 1/2
Square D	33 1/2	28 1/8	30 1/4
Standard Coil Products	23 3/4	14 3/8	21 1/2
Starret (L.S.)	105 1/4	65 3/4	92
Stewart-Warner	52 1/2	42 1/2	49 1/2
Telautograph	13 3/8	9	11
Texas Instruments	131	61 1/4	124 3/4
Thompson-Ramo-Wooldridge	70 1/4	56 1/4	66 1/2
Tung-Sol Electric	54 1/4	34 1/8	48 7/8
Underwood Corp.	30 7/8	20 5/8	27 1/4
Union Carbide Corp.	145	120 1/2	145
United Shoe Machinery	51 5/8	45 5/8	47 5/8
Western Union	39 3/8	29 3/4	37 3/4
Westinghouse Air Brake	38 1/2	32	34 7/8
Westinghouse Electric	88 3/4	70 1/2	87 3/4
Worthington Corp.	80 1/4	70 1/2	74 3/4

1) Not traded - Bid and Asked

OVER THE COUNTER

	QUOTATION AS OF 5/15/59 BID	ASKED
Aerovox Corp.	11	12
Aircraft Radio Corp.	48	-
Argus Corp.	37	38 1/4
Black Sivalls & Bryson Inc.	24 1/4	25 1/4
Eitel McCullough	46	47
Hagen Chemicals & Controls	29	30
Electronics Associates	45	47
Electro Instruments	29 1/4	31
Erie Resistor Corp.	10	10 3/4
Fisher Governor Co.	21 3/8	23
Foxboro Company	55	57 1/2
Ginnini Controls	33 1/4	34 3/4
Industro Transistor	6	6 5/8
Liquidometer Corp.	8 3/4	9 1/4
W. L. Maxson	14 5/8	15 1/2
Penn Controls	23 1/2	24 1/2
Speer Carbon, Inc.	38 1/2	39 1/2
Sprague Electric	50 3/4	52 1/2
Taylor Instruments	35	36 1/2
Telecomputing Corp.	12 5/8	13 5/8
Topp Industries	15 3/8	16 3/4
Varian Associates	37	38 1/2
Vitro Corp. of America	13 7/8	14 1/4

NEW FLOOR MODEL A-F

Wilder MICRO-PROJECTOR with VERTICAL LIGHT BEAM

Quality Control plus Cost Control

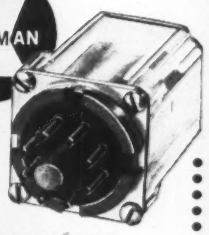
- Completely versatile. For production inspection or as contour measuring projector.
- Choice of 3 measuring stages 1" x 1", 2" x 2", 2" x 4".
- Full set of lenses between 10x and 100x magnification.
- Full length cabinet eliminates separate worktable.
- Detachable shelf optional.

Write for New 12 page catalog 357.

OPTO-METRIC TOOLS, INC.
137 IA VARICK STREET, NEW YORK 13, N. Y.

For more information circle **26** on inquiry card.

KURMAN



SERIES 26D 10 AMP.

KURMAN
MINIATURE POWER RELAY

FEATURES
- Clear polystyrene dust-proof enclosure
- Up to 3 P D T, 10 amp. contacts
- AC or DC coil, up to 15,000 ohms
- Life—100,000 operations minimum
- Dimensions 1 3/8" sq. x 2 1/16" high
- Octal or 11 pin plug-in

STOCKED BY LEADING DISTRIBUTORS FROM COAST TO COAST
For Immediate Delivery at Factory Prices

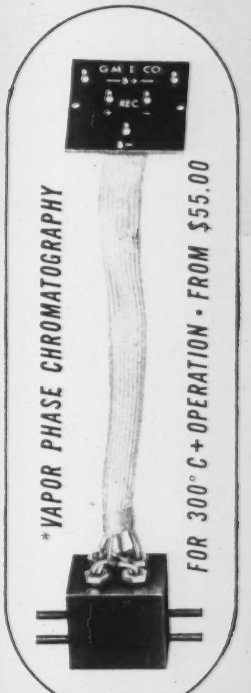
KURMAN ELECTRIC CO.
Division of Norbute Corp.
Quality Relays Since 1928
191 NEWEL ST.
BROOKLYN 22, N. Y.
Export: 135 Liberty St, N.Y.
Cable: TRILRUSH

KURMAN

SEND FOR CATALOG

For more information circle **25** on inquiry card.

BETTER GOW-MAC DETECTORS for VPC*



because every Gow-Mac unit is gas tested for—
- ZERO DRIFT
- NOISE LEVEL
- TRIM
- CURRENT-ZERO-SHIFT

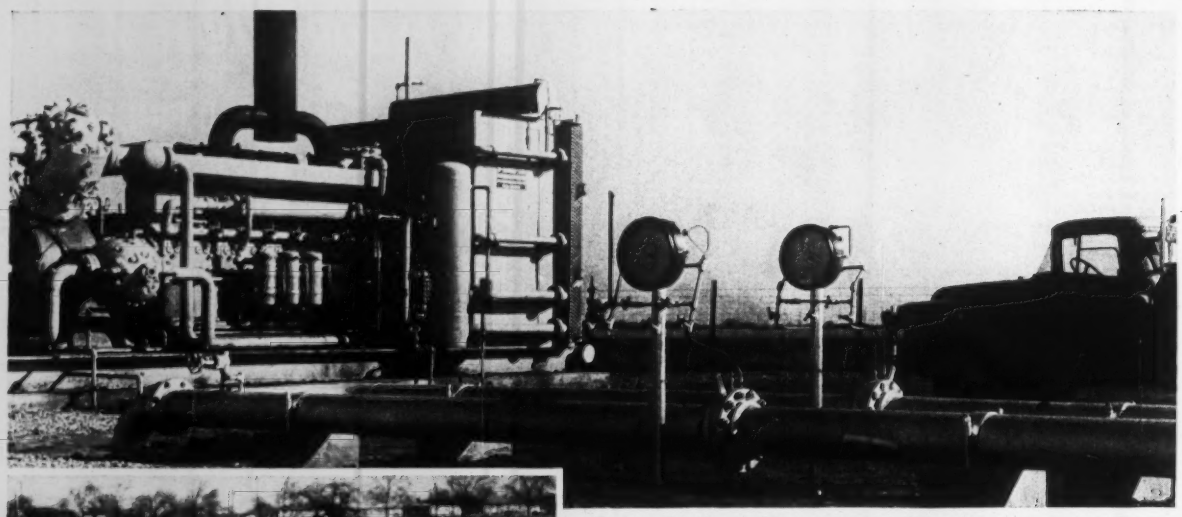
to your specification (DATA SHEET 581). All geometries can be made to your sketch for—
- GAS FLOW CONNECTIONS
- ELECTRICAL CIRCUITRY

for air, oil baths. Dimensional drawings available.

OTHER GOW-MAC PRODUCTS—Portable and Panel Instruments, Power Supplies (20V 500 ma DC) On Stream T/C Cells (Hot Wire and Thermistor), Hot Wire Filaments in matched pairs from stock. Address inquiries to Dept. IA.

GOW-MAC INSTRUMENT COMPANY
100 KINGS ROAD, MADISON, NEW JERSEY, U.S.A. • Tel. FRontier 7-3450

For more information circle **27** on inquiry card.



Foxboro Diaphragm Meters on gas well head measurements at Sunray Mid-Continent's Moore, Oklahoma field. Meters return to zero instantly when flow stops — have no ambient temperature effects, even though temperatures have ranged from −9°F to +105°F.

"the only dry meter with the solid pen-power of a mercury meter"

. . . reports H. H. (Pat) Everett
Sunray Mid-Continent Oil Co.

Fastest zero return of any dry meter on intermittent gas flows. That's just one reason why Sunray Mid-Continent Oil Co. finds the Foxboro Type 37 Diaphragm Meter perfect for gas wellhead flow measurements.

Sunray currently has 47 Diaphragm Meters in operation on gas separator and compressor stations in the Oklahoma City district, with 13 more due to be installed shortly.

District Superintendent H. H. (Pat) Everett also reports that his Diaphragm Meters have never needed calibration since they were installed. And they're completely free from zero drift and ambient temperature effects . . . resulting in the highest sustained accuracy of mercury-less gas flow measurement. No wonder Sunray says the Type 37 outperforms all other dry flow meters!

You'll find Foxboro Diaphragm Meters provide highly accurate, dependable records of all gas flow measurements. Get full details from your nearby Foxboro Field Engineer, or write for Bulletin 7-15A. **The Foxboro Company, 466 Neponset Ave., Foxboro, Massachusetts.**

FOXBORO
REG. U.S. PAT. OFF.

FIRST IN FLOW

For more information circle **28** on inquiry card.

events

June 16-20

Summer Session on Industrial Photoelasticity, on campus of Massachusetts Institute of Technology. For information write William M. Murray, Mechanical Engineering Dept., Massachusetts Institute of Technology, Cambridge 39, Mass.

July 13-17

Summer Program on Strain Gage Techniques, on campus of Massachusetts Institute of Technology. For information write William M. Murray, Mechanical Engineering Dept., Massachusetts Institute of Technology, Cambridge 39, Mass.

August 17-28

Courses In Frontier Research On Digital Computers, sponsored by University of North Carolina, will be held on campus. For information write James G. Steagall, University Extension Div., Box 1050, Chapel Hill, N. C.

August 18-21

Western Electronic Show and Convention, San Francisco, Calif. For information write WESCON, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

August 24-26

Appalachian Gas Measurement Short Course, sponsored by University of West Virginia, will be held on campus. For information write School of Mines, Morgantown, West Virginia.

August 24-28

Gordon Research Conferences on Instrumentation, Colby Junior College, New London, New Hampshire. For information write W. George Parks, Director, Department of Chemistry, University of Rhode Island, Kingston, Rhode Island. After June 15, write c/o Colby Junior College.

August 24-29

Infrared Spectroscopy Institute, sponsored by Fisk University, will be held on campus. For information write James R. Lawson, Fisk University, Infrared Spectroscopy Institute, Nashville 8, Tenn.

September 21-25

Fourteenth Annual Instrument Society of America Conference and Exhibit, International Amphitheater, Chicago, Ill. For information write F. Tabery, 3443 South Hill St., Los Angeles 7, Calif.

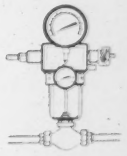
September 22-24

Third Industrial Nuclear Technology Conference, Morrison Hotel, Chicago, Ill. For information write L. Reiffel, Armour Research Foundation, Technology Center, Chicago 16, Ill.

Remote Control of Temperature or Pressure with TRUE Proportional Band Adjustment

Now, the simplest *true* proportional band adjustment in the field . . . a compact, inexpensive unit for positive remote control of temperature or pressure in countless applications. Fast-response bulb sends three- to fifteen-pound air signal to control valve, damper actuator or other control device. Long-life dependability ends pilot control headaches. Available as "blind" or indicating controller.

- Convenient knob adjustment
- Low air consumption
- Small, highly sensitive element
- Simple field reversibility
- True proportional response
- Any 50° range, —20° F. to +380° F. Pressure: 3-35 psi; 5-75 psi; 15-150 psi.



Can be supplied factory mounted on control valve

FOR COMPLETE INFORMATION, WRITE FOR BULLETIN LL-113

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • Knoxville 1, Tennessee

For more information circle **29** on inquiry card.

Case Type No. 1279.

Case Type No. 1379 is Alumalife, while similar case Type No. 1079 is Cast Iron.

Case Type No. 1377.

In such cases DURAGAUGES® naturally serve longer

You have a choice of three case materials—Alumalife®, a special aluminum alloy, Cast Iron, rugged and durable, Phenol, tough and rigid plastic—plus the unique "Maxisafe" design when you specify Ashcroft Duragauges.

All three case materials use a chrome plated, die-cast retaining ring to keep out harmful fumes and dirt. Case construction simplifies servicing—the entire system can be easily removed for recalibration or repair.

The "Maxisafe" case provides absolute protection to the viewer, easy and quick access to the tube and movement assembly. An integrally cast solid wall separates the dial from the tube and movement. A safety cover plate on the back is held in position by a knurled knob.

Regardless of your gauge case requirements, there's an Ashcroft Duraguage to do the job. Contact your local Ashcroft Gauge Distributor for complete facts.

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi.

CASE MATERIALS, TYPE NUMBERS, MOUNTING AND SIZES

CASE	TYPE NO.	BACK FLANGE	MOUNTING		CONNECTION		DIAL SIZE
			WALL	FLUSH	LOWER	BACK	
Black Alumalife	1379	Yes	Yes	Yes	Yes	Yes	4½", 6"
Black Cast Iron	1079	Yes	Yes	Yes	Yes	Yes	4½", 6", 8½" 10", 12"
Black Phenol, Turret Design	1279	No	Yes	Yes*	Yes	Yes	4½", 6", 8½"
Black Alumalife**	1377	No	No	Yes	No	Yes	4½", 6", 8½" 10", 12"

**May be flush mounted by using Flush Mounting Ring, Catalog No. 1278.*
***The 10" and 12" dial sizes are made in cast iron only.*

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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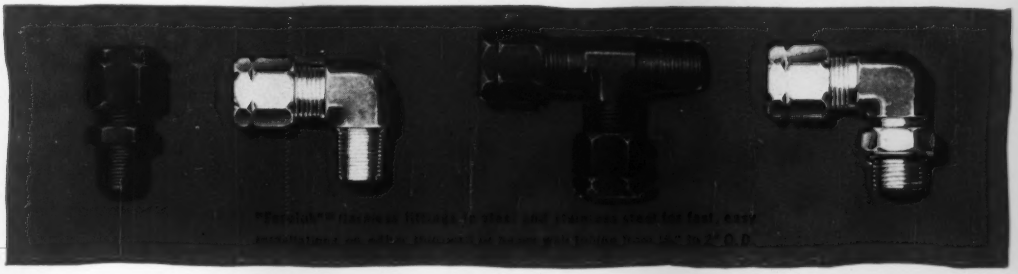

Only from Parker

so complete a range of tube fittings for process and instrument lines

Select the proper tube fittings for any of your process or instrumentation lines from hundreds of different sizes, shapes and alloys in the Parker fittings line.

Parker "Intru-lok" fittings for fast, easy assembly of low- and medium-pressure lines in metal or plastic tubing. Fittings come ready to use without disassembly.

"Triple-lok" flare-type fittings make up leak proof on high pressure, high temperature lines. They are ASME-approved, ideal where safety is vital.

Leak-free, vibration-proof "Ferulok"® flareless, bite-type fittings hold pressure-tight on thin-wall or heavy-wall steel or stainless tubing. For semi-permanent joints on critical applications, use "Braze-lok" fittings on O.D. tubing. And use "Weld-lok" for highest temperatures and pressures.

Call your Parker fittings distributor for prompt delivery of Parker fittings from local stocks. He can also offer expert advice on any process or instrument tubing installation.

Parker FITTINGS AND HOSE DIVISION

17325 Euclid Avenue • Cleveland 12, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

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BREEZE BELLOWS

Because BREEZE Bellows are job engineered for the most exacting applications, they insure high performance and long life. BREEZE offers a wealth of experience in weldable alloys such as Iconel X, titanium, Ni-Span, Hastelloys and Stainless steels. BREEZE Bellows solve tough problems in instrumentation, fuel regulation, pressure switches and expansion joints, hot air ducting, pressure surge tanks, packless valves, oscillating and rotating shaft seals, atomic and nuclear reactors.
We invite your inquiries.

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BREEZE PRODUCTS: ACTUATORS • HOISTS • TRANSMISSIONS • GENERATORS • STARTERS
STARTER GENERATORS • BELLOWS • SLIP RINGS • HOSE CLAMPS • HITEMP FLEXIBLE TUBING

For more information circle **32** on inquiry card.

For your library . . .

100 Electronic Circuits

by M. H. Aronson and C. F. Kezer . . . covers amplifiers, oscillators, pulse circuits, phase shifters, etc. Complete with all circuit component values and response specifications. Paper, 180 pages, 1957. $2.00

Automatic Control Technology

—Modern Theory and Their Usefulness. Includes 90 advanced papers on control technology as delivered in original language (about ½ of book is in English). Cloth, 9 x 12", 508 pages, 1957. $25.00

Digital Techniques for Computation and Control

by Klein, Morgan and Aronson . . . all basic digital techniques within one text . . . code arithmetic, logical networks, multiplexing, conversion, data reduction, digital process control, two-terminal relay circuits, counting techniques, digital computers, programming, digital differential analyzers, and combined analog-digital equipments. Cloth, 394 pages, illustrated, 1958. $6.00

Instruments Publishing Co.
845 Ridge Avenue
Pittsburgh 12, Pa.

EVENTS—CONTINUED

September 23-25
Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Shoreham Hotel, Washington, D.C. For information write John Leslie Whitlock Associates, 6044 Ninth St., North, Arlington, Virginia.

September 28-October 1
Ninth Annual Instrument Symposium and Research Equipment Exhibit, National Institutes of Health, Bethesda, Md. For information write James B. Davis, National Institutes of Health, Public Health Service, Bethesda 14, Md.

October 5-7
Fifth National Communications Symposium, sponsored by IRE Professional Group on Communications Systems, Hotel Utica, Utica, N. Y. For information write C. W. Gordon, 1403 Bedford St., Rome, N. Y.

October 12-14
National Electronics Conference, co-sponsored by Illinois Institute of Technology and two technical societies and two universities, Hotel Sherman, Chicago, Ill.

October 19-21
Joint Fall Meeting of URSI and IRE, El Cortez Hotel, Balboa Park, San Diego, California. For information write IRE, 1 E. 79th St., New York 21, N. Y.

October 28-29
6th Annual Computer Applications Symposium, Morrison Hotel, Chicago, Ill., Armour Research Foundation of the Univ. of Ill., Write M. J. Jans, Conf. Secy., Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

October 29-30
5th Annual Electron Devices Meeting, Shoreham Hotel, Washington, D. C., PGED-IRE, Write J. J. Lanigan, Pub. Chrman, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

November 3-5
1959 Mid American Electronics Conference (MAECON) Midwest Research Institute, Kansas City, Mo., Sponsored by KC Section, IRE. Write Paul C. Constant, Jr., Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo.

November 4-6
Sectional Meeting of Society for Applied Spectroscopy & Instrument Exhibition. Hotel New Yorker, N.Y.C. For information write M. F. Wilson, Air Reduction Corp. Research Lab., Murray Hill, N. J.

November 16-19
5th Conference on Magnetism and Magnetic Materials, Sheraton-Cadillac Hotel, Detroit, Mich., Sponsored by Univ. of Mich., IRE, Am. Phys. Soc., ONR, AIEE and Met. Soc of AIME. Write D. M. Grimes, Dept. of E. E., Univ. of Mich., Ann Arbor, Mich.

November 16-20
Fifth International Automation Exposition, The New York Trade Show Building, 500 Eighth Ave., New York City. For information write Richard Rimbach Associates, Mgmt., 845 Ridge Ave., Pittsburgh 12, Penna.

Ten To One

New Fenwal Monitor simultaneously brings 10 remote temperature signals to one central location

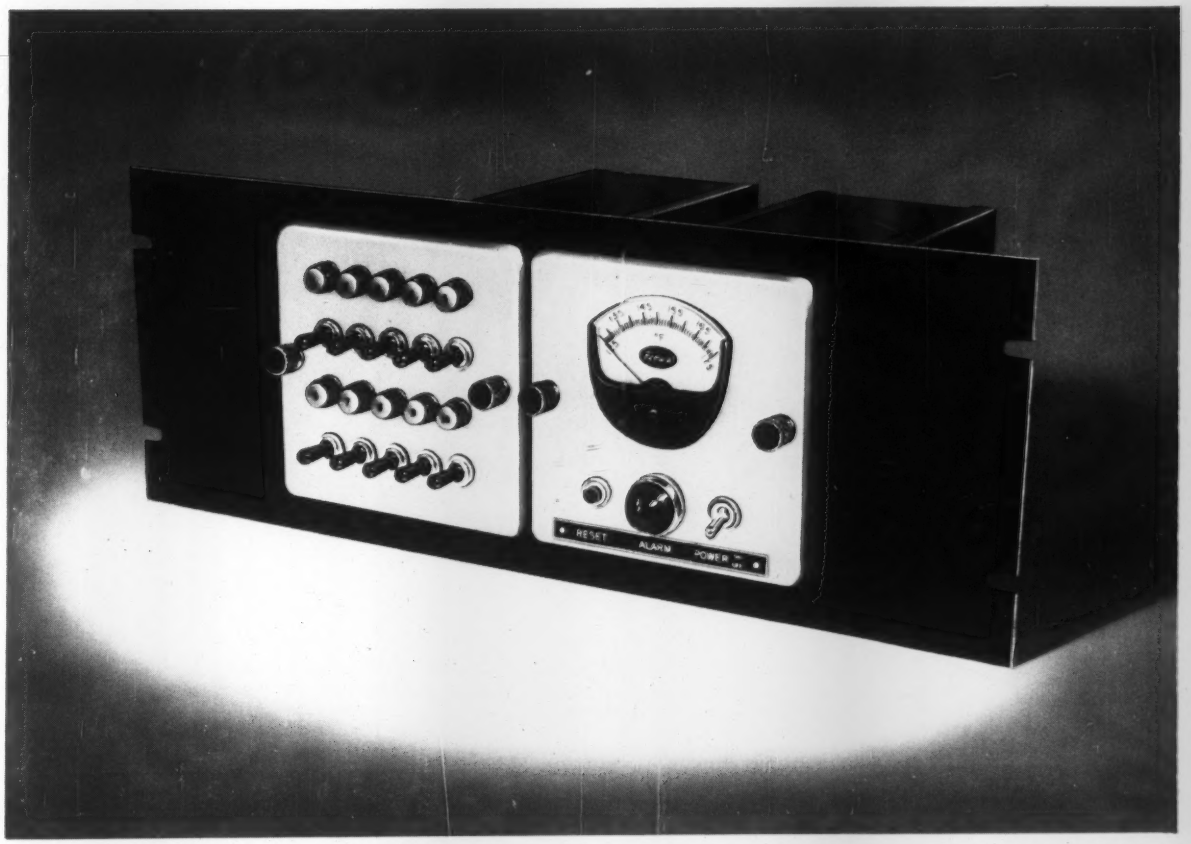
Now there's a monitor that continuously and simultaneously senses all ten of its temperature points. No scanning required . . . no delay in signalling "off" temperatures. *Ten to one it's the positive, fast-acting protection you've needed!*

Monitor's solid-state components are simple, accurate and reliable. Fenwal thermistor sensors install economically with uncompensated electric wiring, have practically limitless life. They change resistance sharply when temperatures change, send strong electrical signals to a rugged, transistorized amplifier. *Wear-free, non-moving parts that combine high performance with low maintenance!*

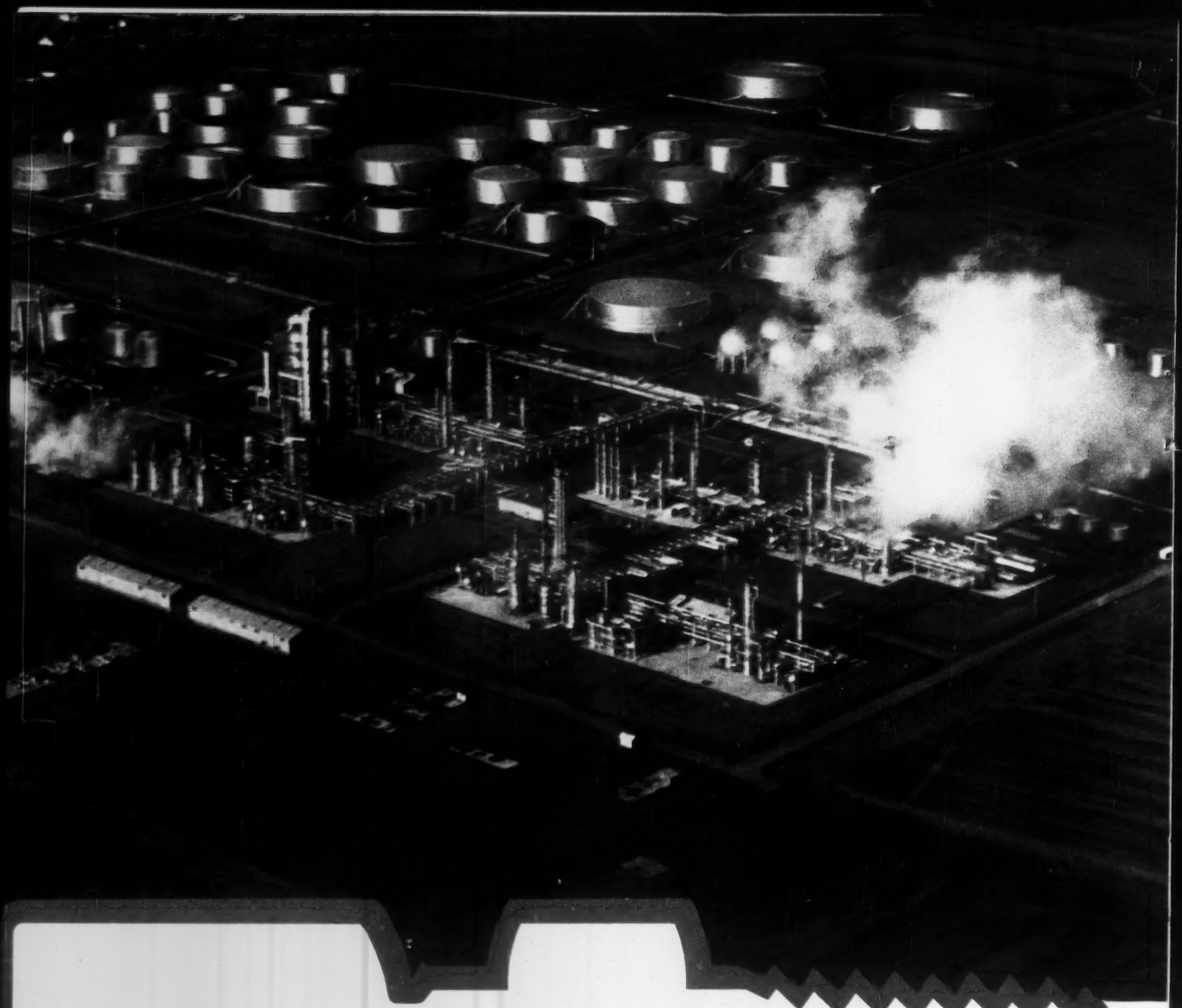
Fenwal Simultaneous Monitoring Systems are produced by a company with highly integrated design and manufacturing facilities, including its own source of thermistors. And they're repeatedly proving this "better engineering" in all the new commercial jets and many military aircraft. *Small wonder they're dependable on the toughest industrial assignments!*

For complete details or complete engineering of your specific temperature monitoring problem, contact a Fenwal Sales Engineer and write for Catalog. Fenwal Incorporated, 366 Pleasant Street, Ashland, Mass.

Fenwal Continuous 10-point Monitor indicates one or more "off" temperatures by red light or other signal. Operator merely flicks toggle switches to locate trouble. Dial shows each temperature. Temperature Range: 100°F ranges from −25 to 600°F. Voltage rating: 115/230 VAC.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

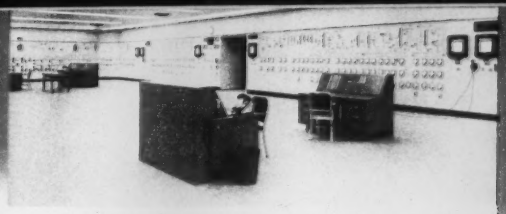


NO COMPROMISE WITH QUALITY IN THIS MODERN PETROLEUM PLANT

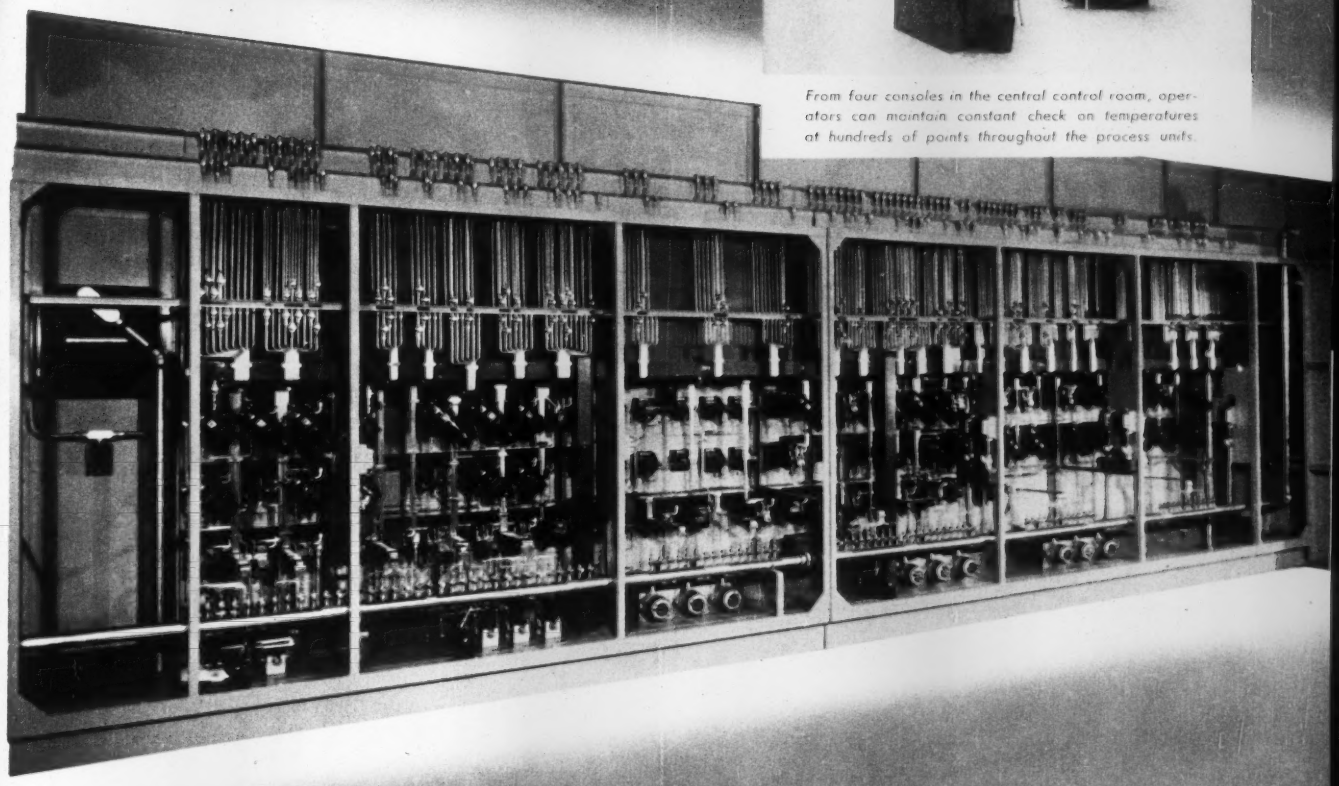
The capacity of this new Texaco Refinery at Anacortes, Washington, is 45,000 barrels of crude oil per day, processed into a full range of finished Texaco quality products . . . high octane and regular gasoline, jet fuel, burner oil, kerosene, diesel oil, bunker fuel and propane gas.

Quality control is the watchword here . . . with automation and instrumentation bearing the major responsibility. More than 30,000 Swagelok Tube Fittings were used for instrumentation and steam tracer lines throughout the plant, including over 12,000 for the panel boards in the control center. In keeping with their high standards of quality in panelboard manufacturing, Swanson Engineering & Manufacturing Co. selected Swagelok Tube Fittings to secure precision control with torque-free seals that are absolutely tight. In the science of sealing, Swagelok Tube Fittings approach the ultimate desired by designers today.

CREDITS: Owner: Texas Company. Complete engineering procurement and construction: Bechtel Corporation, San Francisco, Calif. Panel Boards for Central Control Room manufactured by Swanson Engineering & Manufacturing Co., Inglewood, Calif.



From four consoles in the central control room, operators can maintain constant check on temperatures at hundreds of points throughout the process units.



This view of back of panel board illustrates the outstanding craftsmanship in design and construction by SWANSON ENGINEERING & MANUFACTURING CO.

In this great new Texaco Refinery Swagelok Tube Fittings stand guard against pressure, vibration and torque

In the refining of 45,000 barrels of crude per day at the new Texaco Refinery, obviously all of the units in the process control line must bear a big load of trust in performance.

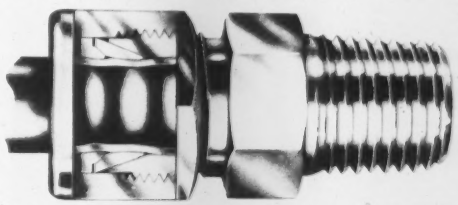
The Swagelok Tube Fittings used in the plant and control panels represent 30,000 trusts in dependable performance. Their design is unique, based on the principle that

nothing is quite so good as the finest that man's ingenuity can create and that precision machines can produce!

The new Texaco Refinery at Anacortes, Washington, is one of many different industries using Swagelok Tube Fittings for trouble-free, leak-proof operation.

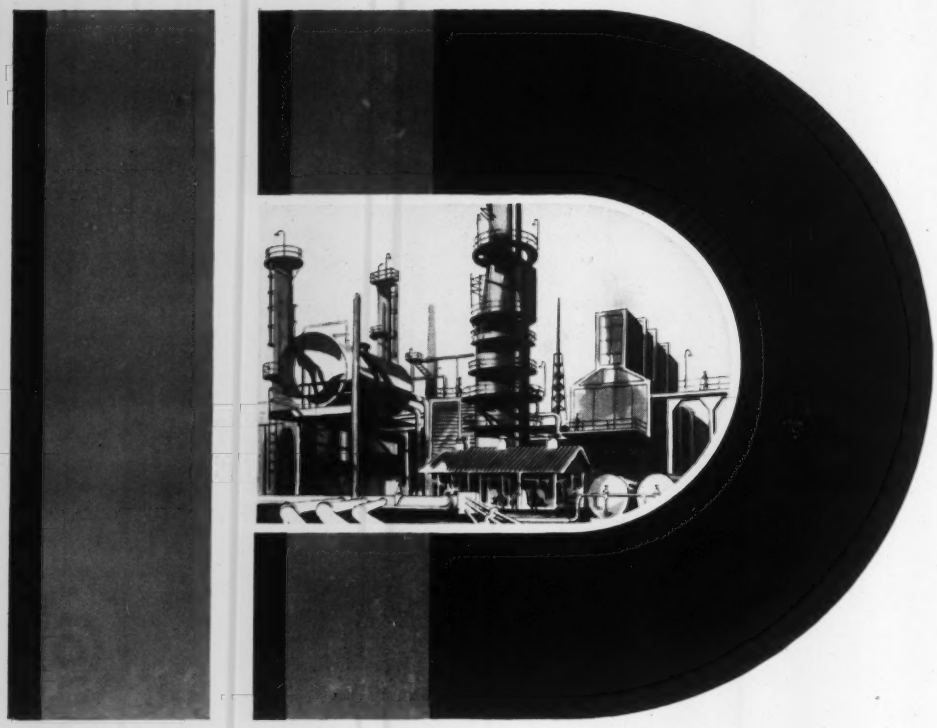
Crawford Fitting Company
884 East 140th St., Cleveland 10, Ohio
Crawford Fittings (Canada) Ltd., Niagara Falls, Ontario, Canada

Swagelok®



Swagelok Tube Fittings are available in any machinable metal or plastic, in sizes for 1/16" through 1" O.D. tubing.

Printed in U.S.A.



D + UOP = An important announcement to the petroleum refining industry!

Daystrom Systems and Universal Oil Products Co. announce a cooperative effort in the application of computers to the control of industrial processes.

For the first time, the facilities and engineering talents of leading process designers and computer systems specialists are combined to offer a unique service to the customer. Daystrom contributes experience and leadership in the design and manufacture of highly reliable computer equipment. Universal Oil Products Company contributes extensive experience and know-how in process design.

Two and one-half years of intensive work have yielded important progress in a pilot plant installation incorporating a Daystrom digital computer control system.

This project marked the first process control application of a solid state digital computer specifically designed for on-line operation in the process industries.

The Daystrom Systems computer completely eliminates vacuum tubes and moving parts. More than two years of field operating experience permits Daystrom to guarantee system operational availability of more than 99%. A substantial number of Daystrom computer systems have already been purchased for control and data reduction.

Daystrom has been granted license to manufacture and market control systems developed by Universal Oil Products and Daystrom Systems. Processes and techniques considered confidential by Daystrom clients will be handled by Daystrom Systems independently.

The advanced techniques and equipment developed by Daystrom Systems are available to you. For conference arrangements, write or telephone Daystrom Systems, A-107, Miramar Rd., La Jolla, Calif., GLencourt 4-0421.

INPUT CONSOLE FOR PROGRAMMING COMPUTER.

DAYSTROM SYSTEMS
DIVISION OF DAYSTROM, INC.
Reliable computer control systems

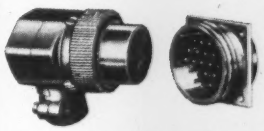
← Circle **34** on inquiry card.

For more information circle **35** on inquiry card.

cam-8-k

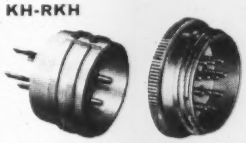
RELIABLE MULTI-PURPOSE "K" SERIES

K STANDARD



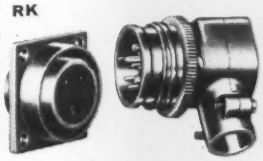
FOR AIRCRAFT, ELECTRONIC, INSTRUMENT, MILITARY, MISSILE, INDUSTRIAL AND COMMERCIAL APPLICATIONS Standard K and RK , in straight and angle 90° plugs with wall mounting receptacles. Conduit and clamp entry types. 1 to 110 contacts in 250 different insert arrangements. 10, 15, 30, 40, 60, 80, 115 and 200 amp. silver plated brass on copper contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 110 to 5000V, 60 cps ac rms.

KH-RKH



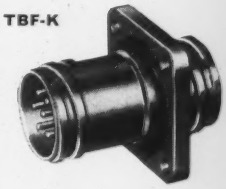
FOR USE UNDER CRITICAL PRESSURE AND LEAKAGE CONDITIONS—Hermetically sealed plugs with steel shells, steel contacts, and Canseal glass insulators for true hermetic sealing. Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

RK



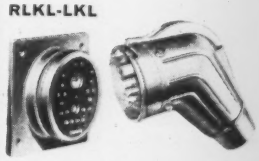
FOR FLUSH OR SEMI-FLUSHMOUNTING—Cannon RK Plug assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K Series. Note: RK will mate only with RK's.

TBF-K



FOR CARRYING CIRCUITS THROUGH BULKHEADS Cannon TBF-K Bulkhead Plugs feature a double-faced construction allowing mating at both ends. Pin inserts. Single piece shell.

RLKL-LKL



FOR TV AND OTHER PANEL SWITCHING OPERATIONS—Quick connect and disconnect RLKL Plugs are designed for one-hand fast disconnect use on TV station program switching panels and similar type operations. Feature a quick coupling means. Latch-lock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

FW-K FWR-K

FOR OPEN FLAME PROTECTION AGAINST HIGH TEMPERATURES—Cannon K Firewall Plugs are available in straight and angle 90° shell types. Wall mounting receptacles also available. Phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon originated the firewall connector and continues to be the leader in this important field.

SK-M7-21C

FOR USE IN TELEPHONE "BEEPER" AND SIMILAR APPLICATIONS—Widely used on telephone recording units known as "beepers." Adaptable for other similar applications.

K ACCESSORIES—Cannon K Series Accessories include Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, and Dummy Receptacles to hold and protect plugs when not in use.

Cannon has available a wide variety of other Plug designs FOR EVERY CONCEIVABLE APPLICATION...including aircraft and electronic Plugs conforming to Specification MIL-C-5015D; Unit-Plug-In Rack/Panel and Modular; Audio and Low-Level Circuit Plugs; Miniature and Sub-Miniatures; Coaxial RF Series Plugs, Printed Circuit Plugs; GM Plugs and Cannon Plug/Harness Systems: "Kwik-Term" Terminals and DC Solenoids.

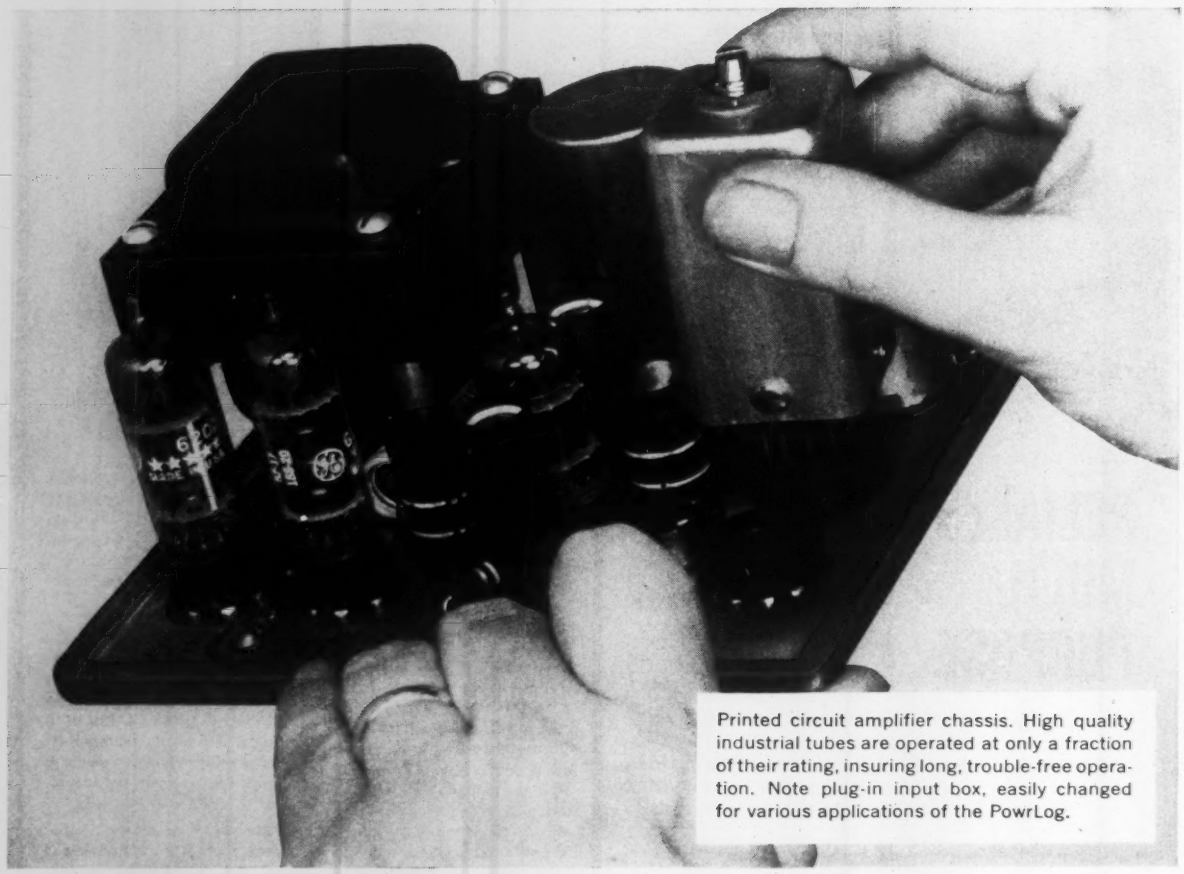
FOR ADDITIONAL INFORMATION on the typical designs illustrated...other configurations for your specific applications...or the design, engineering and manufacture to your special needs...write to **Cannon Electric Company**—3208 Humboldt Street, Los Angeles 31, California. Please refer to Dept. 000.

LARGEST FACILITY IN THE WORLD FOR PLUG RESEARCH-DEVELOPMENT-MANUFACTURE

CANNON PLUGS

Factories in Los Angeles, Santa Ana, Salem, Toronto, London, Paris, Melbourne, and Tokyo. Distributors and Representatives in the Principal Cities of the World.

For more information circle **36** on inquiry card.



Printed circuit amplifier chassis. High quality industrial tubes are operated at only a fraction of their rating, insuring long, trouble-free operation. Note plug-in input box, easily changed for various applications of the PowrLog.

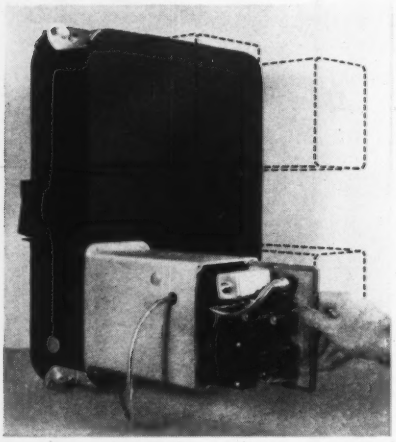
For low cost, linear, remote recording and control...THE NEW HAGAN HO POWRLOG

- for RESISTANCE BULB THERMOMETRY: −100 to +600 F
- for SUMMATION or SUBTRACTION: up to 10 variables
- for TELEMETERING: flows, levels, pressures
- as a CONDUCTIVITY recorder

The Model HO PowrLog features low maintenance, a high degree of accuracy, no chopper, the use of a unique amplifier and plug-in input boxes—one for each type of measurement. Its low first cost, and the elimination of parts stockpiling problems, makes the Model HO the most economical receiver of this type on the market.

Utilizing a modified Wheatstone bridge circuit, all parts, including the high-gain AC amplifier, were selected for reliability, accuracy and long wear characteristics. The use of plug-in input boxes provides a degree of flexibility unavailable in other instruments. The Model HO PowrLog is also available with input boxes for DC measurements above 100mv. This unit employs a transistor chopper network.

Write for Specifications Sheet OE 10003, or ask a Hagan engineer to explain the many cost-saving advantages and variety of applications for the PowrLog instruments.



Up to four PowrLog receivers may be mounted on the one case. All four variables may be recorded on the same chart.

HAGAN CHEMICALS & CONTROLS, INC.

DIVISIONS: CALGON COMPANY, HALL LABORATORIES

HAGAN BUILDING, PITTSBURGH 30, PA.

In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Fiumendosa No. 13, Milano, Italy

For more information circle **37** on inquiry card.

panhandle pete

WESCO! Shows

"Cuzes, er, gentlemen, I am happy (cough) to be here today and report to you on the various little expenses incurred at the last and very successful trade show in which WESCO got stu . . . er, exhibited," said Waldo Klapsaddle, genial sales manager of WESCO! as he addressed the special meeting of the Board of Directors, called especially to hear how one show could cost $8,884,594.74.

The first question from the floor came hurling up with an empty pop bottle, which Waldo expertly ducked. "Why did you go into such an expensive show?"

"The floor space was very reasonable," answered Waldo patiently, taking an empty shoe on his ear without flinching. "Only $132,546, and for enough room to get at, er meet, more than 100 men at a time. Of course there was a slight extra charge for water and air—$264,192, to be exact—but you can't hardly pour a good drin . . er, run a good line of instruments without water and air."

"That's only $400,000," screamed a wild-eyed vice president, trying to get room to swing a hickory bat. "Where did the other $8.4 million go?"

"Gentlemen, gentlemen," replied Waldo. "You can't invest $400,000 in an empty booth. That Raymond Loely designed booth was cheap at $2,643,175.26. Everybody noticed it right away." Here Waldo, stooping real low to avoid a typewriter, took a spitoon full in the face.

"You're still $5 million shy," roared another VP, sighting along a beautiful new rifle.

"But you can't just go to a show with an empty booth, gentlemen," says Waldo, from behind a partition. "We gave out 41,562 copies of our full catalog on the first day. You know they cost $8.02 apiece. We considered sending a crew into all local men's rooms, bars, high-school libraries, competitor's hotel rooms and other places where these catalogs probably ended up, but we decided to be safe. After all, we had a lot invested" . . . Here Waldo took a full load of buck shot without even flinching—sales managers are very brave indeed. "So we ordered another 50,000 catalogs for overnight delivery. Owing to the fast service, they cost just a little more—$80 apiece." Here Waldo wipped out his sliderule and proudly announced, "50,000 catalogs at $80 apiece is $3.9 million, every cent essential."

"And you can't have no action, neither," continues Waldo, holding back two vice presidents, one trying to bite off an ear, the other kicking him in the . . . "You must have something dynamic. This was two beautiful models, each in operation in front of our O. J. Computer. That really got a crowd. The computer cost only $124,000, and the girls cost $345,621.23. But they were worth it, yes sir, I can tell you myself." Waldo here got a dreamy expression and almost took a desk right in midriff.

"For those people who the girls couldn't get into the booth—after all, they are human—we gave one Hartzburg Kanarienvogle Gas Analyzer, plus a sample of FE_2D. Even bird feed isn't bird feed these days, you know! This essential gesture costs only $742,364.25, but a lot of people at that show thought of our gas analyzer every time they looked at their suits."

"You're still $300,000 short," yelled an executive with a red face.

"Oh, that's simple," says Waldo. "We spent that at the hotel. You don't expect us salesman to live like hogs do you? . . ."

"But now we're bankrupt," sobbed an old vice president pitifully.

"Cuz, er sir, don't you worry about that," replied our resourceful Waldo. "We expect to get the business from the trade show next month."

Panhandle Pete

A Logical Deduction

Because ordinary magnetically-regulated power supplies are **too sluggish** to handle load and line transients,

Because NJE refused to be satisfied with such performance, and developed, back in 1956, a **fundamentally superior circuit,**

Because this thoroughly proven circuit uses the speed and power-gain of a transistor amplifier to force rapid response from the magnetic amplifier,

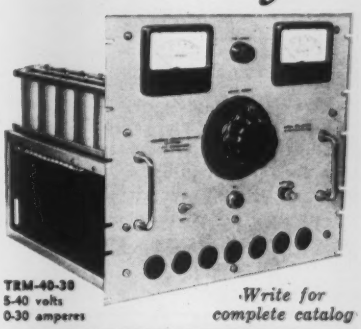
Because the transistors are never in the power path, but handle low-level signals only,

Because this transistor-magnetic—"TRM"—circuit retains the reliability and economy of magnetically-regulated supplies, but greatly improves speed of response (15 millisec. typical) widens operating range (8:1 typical) and tightens regulation (0.1% typical),

Because TRM supplies can be "zero-lagged" against line and load transients,

It follows that NJE TRM is your **best buy** in a magnetically-regulated power supply!

QED... choose NJE



TRM-40-30
5-40 volts
0-30 amperes

Write for complete catalog

MODEL NUMBER	OUTPUT RANGE VOLTS	AMPERES
TRM-28-30	24-32	0-30
TRM-28-60	24-32	0-60
TRM-28-120	24-32	0-120
TRM-40-15	5-40	0-15
TRM-40-30	5-40	0-30
TRM-40-60	5-40	0-60
TRM-40-120	5-40	0-120
TRM-80-7.5	10-80	0-7.5
TRM-80-15	10-80	0-15
TRM-80-30	10-80	0-30
TRM-80-60	10-80	0-60
TRM-160-7.5	20-160	0-7.5
TRM-160-15	20-160	0-15
TRM-160-30	20-160	0-30

NJE CORPORATION
345 Carnegie Avenue, Kenilworth, New Jersey
CH 1-1500 TWX - Roselle, N. J. 51 FAX - FFP

For more information circle **38** on inquiry card.

BRISTOL'S INSTRUMENTATION

★ *News and information about automatic controlling,*

Instrument measures, controls any process variable that can be transduced to an electrical quantity

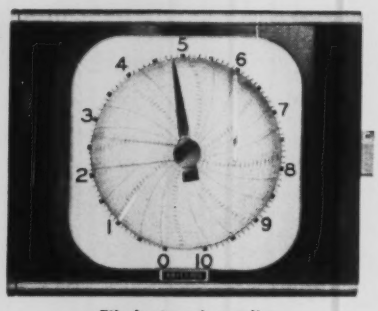
Bristol Electronic Dynamaster* potentiometer and bridge instruments embody design features for utmost accuracy. Many models, many accessories made for extreme versatility

"Over design" insures reliability

The Dynamaster's simple design with few moving parts, plus "over design" in all components insures long life. Easy to use and service, the instrument requires little or no maintenance. Rugged construction . . . ideal for industrial plants, and pilot plants . . . gives the Dynamaster exceptional vibration resistant qualities.

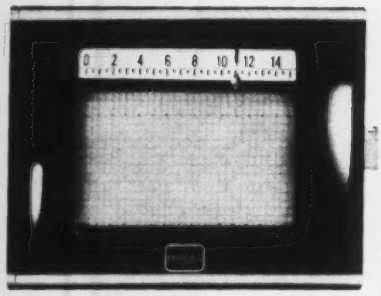
High instrument accuracy

Conservatively rated components, Bristol's careful design and manufacture, combined with the proved Dynamaster motor-driven null-balance principle insure high instrument accuracy and precision in fast electronic measurement and control. Used in miniature as well as full-sized Dynamasters, the motor-driven null-balance design not only provides high accuracy, but also affords plenty of torque for operating alarm contacts, analog to digital converters and other control devices.



Eliminates dry cells

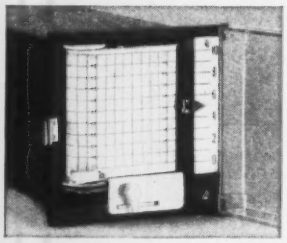
"No-Batt" continuous standardization, available as an optional feature, accurately and automatically standardizes the potentiometer against standard cell continuously, without interruption to service. Dry cells and the usual standardizing mechanism are eliminated. *T.M. Reg. U.S. Pat. Off.



Wide range of models

Dynamaster round chart instruments are available in one- or two-pen models. Strip chart models are available as single-pen, two-pen or multiple-record instruments up to 24 points. Dynamaster models for research and testing include: High speed (0.4 sec) Recorders; Two-Pen Recorders; X-Y Recorders (function plotters); Extended Range Recorders; Adjustable Span and Zero Recorders.

Electronic Dynamaster Pneumatic Transmitter



The Dynamaster is now available as a recording or indicating pneumatic transmitter. This new miniature instrument is offered as a potentiometer, pyrometer, d-c bridge, or a-c bridge for making such measurements as resistance, conductivity, strain, and many others, or it can be a differential-transformer receiver. It continuously transmits a 3-15 psig air pressure signal which can be used to operate recording and controlling pneumatic instruments, such as Bristol Metagraphic Instruments. Full size Dynamaster air control instruments are, of course, also available.

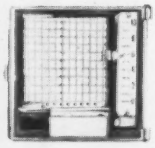
Many electric and pneumatic controllers

Dynamaster round- and strip-chart instruments are available with a wide variety of controllers, both electric and pneumatic.

Electric controllers include on-off, proportional input, 3-position, proportioning, proportional with automatic reset and time program models.

Pneumatic control models include on-off, proportional, proportional with reset and proportional with reset and derivative types in addition to the Dynamaster Pneumatic Transmitter described above.

Dynamaster recorders can be equipped with analog to digital encoders or converters of various types for readout or computer use. This feature extends the already wide range of applications for which Dynamaster instruments are suited.



"Plug-in" miniatures

Bristol miniature Dynamasters (Series 663) take only 5" x 5⅛" panel space. A true plug-in chassis permits 10-second changeover from an indicator to recorder, lets you plug in spare instruments with minimum interruption to control. Miniatures utilize the same highly accurate, motor-driven null-balance principle as full sized Dynamasters which assures ample torque for operating auxiliary equipment or contacts—another advantage over ordinary galvanometer type instruments.

Dynamaster records stomach acidity

Here's a novel Dynamaster application in medical research. Dr. Joseph Gambescia, at Hahnemann Medical College and Hospital, uses a Bristol Recording Potentiometer to study effects of various alkalinizing agents on stomach acidity. The transducer that feeds the Dynamaster is a specially developed glass electrode which is swallowed by the subject.

For more information circle **39** on inquiry card.

NEWS AND NOTES

recording and telemetering instruments from Bristol

The now-famous Shippingport, Pa., Atomic Power Station is the United States' first full-scale central station nuclear power plant devoted exclusively to civilian use. Westinghouse Electric Corporation designed and developed the nuclear portion of Shippingport under the direction of and in technical cooperation with the Naval Reactors Branch, U. S. Atomic Enerrgy Commission.

The Bristol Company is one of the intrument suppliers furnishing electronic potentiometer and bridge instruments used here.

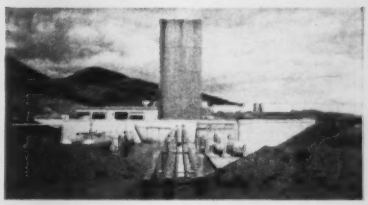
Complete temperature profiles increase yield at LCA

Control of time-temperature relationships in decrepitation of lithium ore is critical. Too high temperatures in the huge 250′ rotating kiln at the Lithium Corporation of America, Bessemer City, N. C., plant could cause clinker rings and reduce yield. If temperatures are too low the desired chemical conversion will not take place. The problem was how to continually measure internal temperatures throughout the entire length of the kiln. Bristol instrumentation was the answer.

Instruments provide complete temperature profiles within the initial kiln and monitor every step of the process to the final continuous crystallizer. Operators above spot checks temperatures at Bristol panel board. B-47

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



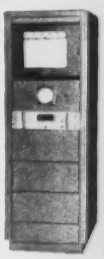
Testing the Titan

A panel of Bristol electronic instruments at Martin-Denver Division's Propulsion Laboratory above aids propulsion tests of the Titan ICBM, largest of the Air Force missiles. These Dynamaster recorders were installed as part of the test equipment supplied by Pomona Division, Marquardt Aircraft Co., formerly Associated Missile Products Co. They are used to check out kill parameters during tests. Monitoring engineers can stop tests if the red line limits on critical readings are exceeded.

Record wind tunnel data

Fourteen strip chart Dynamaster millivoltmeters record aerodynamic data from variable resistance strain gages on models under test in the Boeing supersonic wind tunnel. Each recorder is equipped with analog-to-digital converters which convert the Dynamaster potentiometer shaft rotation to digital output. The complete hookup makes possible immediate presentation of computed data simultaneously with the running of the test.

New Dynamaster fits standard 19″ relay rack



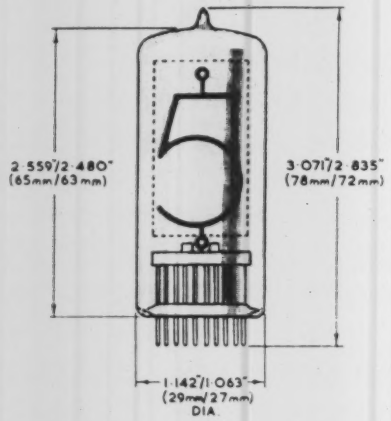
Many Dynamaster models now fit into standard 19″ relay racks without modification to rack or instrument. These are the first such instruments that may be so installed without cutting or masking. For more facts, write: The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

For more information circle **39** on inquiry card.

briefs

10-Digit Direct Readout Tube

The Digitron is a cold cathode Register Tube indicating the digits 0 through 9. These tubes extend the usefulness of the versatile Dekatron counting tubes by providing a more efficient direct readout capability. The chosen digit may be illuminated by grounding the



appropriate connection. Alternatively, the tube may be used to display the state of count of a ring of ten cold cathode or themionic tubes by taking the cathodes of the register tube to the anodes of the counting tubes.

The Digitron is ideal for use in a remote readout or indicator panel where the state of count at a selected control tube would be monitored . . . (*From new* 2-*page Leaflet* 9532, *Baird-Atomic, Inc.*, 33 *University Rd., Cambridge* 38, *Mass.*)

For this literature circle **161** on inquiry card.

13,000 Instruments For Rent

Specializing in Rentals, the Schenectady Center stocks all types of portable and special units; and, all are available to you at monthly rental fees . . . For example, rather than purchase a deluxe oscilloscope for temporary use at a cost of $1500, a manufacturer can rent one for less than $75 per month. This saves hundreds of investment dollars and still satisfies the desire for a special instrument when the need develops. To fulfill the demand for standard and specialized instruments, the Schenectady Instrumentation Service maintains an inventory consisting of approximately 250 different categories for a total of 13,000 instruments . . . . One customer's application involved the rental of more than 60 different indicating instruments to undertake an acceptance test on new power generation equipment . . . Approximately 65 per cent of the Schenectady Instrumentation Service's rentals involve electric instruments . . . This area of rental instruments include all types of process instruments which measure pressure, flow and temperature. The units undergo constant recalibration and modification in order to meet specific requirements of different industrial applications . . . Numerous types of electronic instruments including oscilloscopes, vacuum tube voltmeters, direct writing oscillographs, amplifiers and many others, are available for immediate rental . . . (*From new* 8-*page Bulletin GEA*-6829, *General Electric Co., Schenectady Instrumentation Service, Schenectady* 5, *N. Y.*)

For this literature circle **162** on inquiry card.

Fundamentals of Gas Chromatography

A gas chromatography analyzer consists of the following basic elements: (1) separation column (tubing packed either with an absorbent or an inert solid coated with a stationary absorbing liquid, (2) flow control equipment to maintain a stable flow of carrier gas through the separation column, (3) sample introduction device located upstream from the separating column, and (4) detection device for evaluating the quantity of separated components.

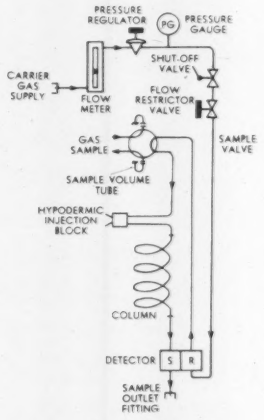


FIGURE A
BASIC MODEL 1A WITH GAS SAMPLE VALVE

Separation of the components occurs because each has its own characteristic elution time from the separation column. This time is dependent upon several factors, including the equilibrium partial pressure over the separating column packing. If this is high, the component is carried rapidly through the column by the carrier gas. If it is lower, the component will travel more slowly through the column. The equilibrium relationship is controlled by column temperature and type of column packing. Component transport time for a given column and temperature is controlled by carrier gas flow and pressure. A sensitive detector and rapid-response recorder are required for adequate presentation of results . . . (*From new* 4-*page Product Data File COF-2, Loe Engineering Co.*, 237 *N. Fair Oaks Ave., Pasadena, Calif.*)

For this literature circle **163** on inquiry card.

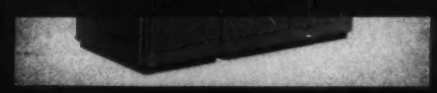
S-C 4020 HIGH-SPEED MICROFILM PRINTERS

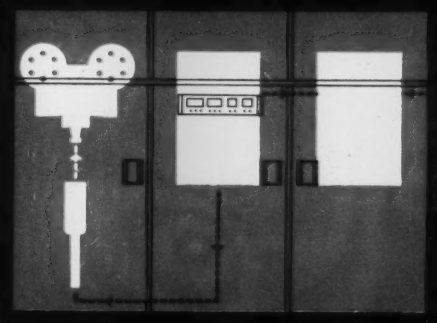
Capable of printing characters and plotting points at the rate of 15,000 per second, the S-C 4020 is equally adaptable to commercial and scientific applications where high-speed microfilming is required. This versatile new printer is compatible with most high-speed data processing systems used throughout business, government and industry . . . and is capable of both on-line and off-line operation. The S-C 4020 has resulted from experience gained by Stromberg-Carlson in the development, manufacture and field testing of other microfilm printers in the S-C 4000 Series, including the S-C 4000, custom-developed for use with the Livermore Automatic Research Computer (LARC), and the S-C 4010, now used in conjunction with the Naval Ordnance Research Calculator (NORC).

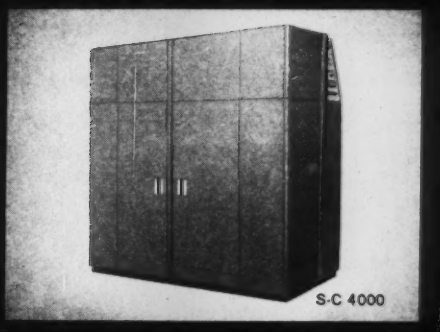
Send for complete information concerning the S-C 4020 High-Speed Microfilm Printer. Ask for Bulletin 6-I. Write today: Stromberg-Carlson - San Diego, 1895 Hancock Street, San Diego 12, California.

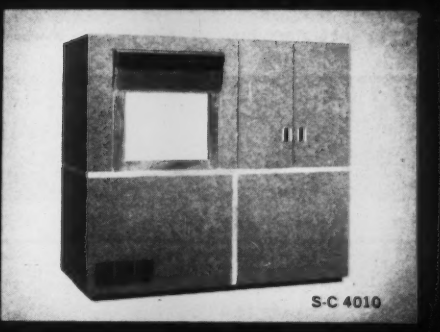
GENERAL DYNAMICS
STROMBERG-CARLSON DIVISION

For more information circle **40** on inquiry card.

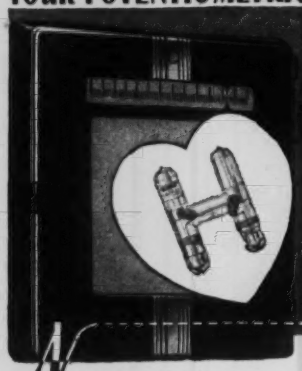








YOUR POTENTIOMETRIC INSTRUMENTS



HAVE A HEART TOO!

NO matter how perfect otherwise, the human organism isn't much good without a dependable heart. The same is true of your automatic temperature and pH control instruments.

The "heart" of most such instruments for the past quarter century has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature or pH. The first American commercial cell of its type, constantly improved by research, it is "as standard as sterling".

Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

The Eppley Laboratory, Inc. 2 Sheffield Ave., Newport, R. I.

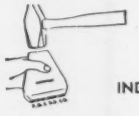
EPLAB *Standard* CELLS
FOR POTENTIOMETRIC INSTRUMENTS
"As Standard as Sterling"

For more information circle **41** on inquiry card.

BRIEFS—CONTINUED

Marking Machines

Marking devices include . . . metal-marking machines and tools; nameplate stamping machines; hand, pneumatic and motor-driven machines; hot stamping



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A Acro Inks
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Acroleaf Presses
Acrolite Signs
Acromarker
Acroprinter
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Automatic Marking Machines
Automatic Numbering Heads

B Bronze Tablets & Signs

C Cable Markers
Cold Stamping Machines
Color Filling Machines

E Electric Signs
Embossing Machines (Gold)
Embossing Machines (Metal)

N Name-Plate Presses
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P Pencil & Round Parts Printer
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Plastic Printing Machines
Pneumatic Marking Machines
Printing Inks
Printing Machines (Automatic)
Printing Machines (Hand)
Printing Machines (Power)

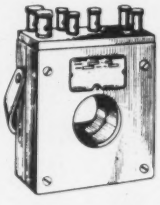
R Ribbon Marking Machines
Rod Marker
Roll Leaf Foil

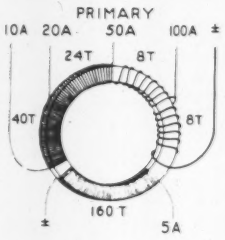
presses for plastics, printing machines, signs, tablets, nameplates . . . (*From new 16-page pocket-size booklet "Marking and Numbering Machines," Acromark Co., 9-13 Morrell St., Elizabeth 4, N. J.*)

For this literature circle **164** on inquiry card.

Electrical Measuring Instrument Accessories

Shunts: The maximum current which can be pressed through moving coil and springs of a typical d-c instrument will be of the order of 0.03 ampere and for higher ranges the bulk of the current is passed through a parallel resistance or shunt. For ranges of up to about 40 amperes these shunts may be internal in the instrument and can be disregarded.





For higher ratings an external shunt is used, amounting to a carefully adjusted four terminal resistance . . .

Multipliers or Series Resistors: Voltmeters, both d-c and a-c, as well as wattmeters are usually limited to 300 volts for the top range although some are occasionally made with internal resistance for as high as 750 volts. For voltages higher than the self-contained rating additional series resistors, commonly called multipliers, are employed and may be available . . . (*From new 8-page Pamphlet "Electrical Measuring Instruments In The Experimental Laboratory," by John H. Miller, Weston Instruments, Div. of Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.*)

For this literature circle **165** on inquiry card.

5,000,000 DATA BITS...AND YOU CAN'T LOSE ONE!

5,000,000 data bits or more are recorded on a reel of tape used in digital recording! Your data processing operations depend on the flawless recording *of every single bit.* This kind of performance calls for a high degree of specialization in the tape itself, a tape designed specifically for this use...

SOUNDCRAFT TYPE A TAPE FOR DIGITAL RECORDING—Only SOUNDCRAFT with the world's newest, most modern tape manufacturing facilities, has engineered all the critical properties required for digital recording into a single tape. The result: on transport after transport SOUNDCRAFT Type A Tape out-performs and outwears all competitors by as much as 7 to 1. Why risk costly errors? Use error-free SOUNDCRAFT Type A Tape for Digital Recording. Write for SOUNDCRAFT Type A Tape Brochure.

Packed in the new exclusive zip-lip envelope for permanent dust-free storage.

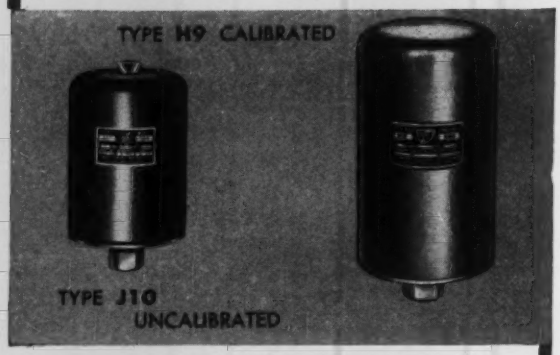
REEVES SOUNDCRAFT CORP.

Dept. I-6, Great Pasture Rd., Danbury, Conn. • 342 N. LaBrea, Los Angeles, Calif. • Canada: 700 Weston Rd., Toronto 9, Ont.

For more information circle **42** on inquiry card.

Sensitive H9 J10

PRESSURE and VACUUM CONTROLS



UNITED ELECTRIC's Type H9 and Type J10 controls are highly sensitive precision built pressure and vacuum controls designed for applications where close on-off differentials and constant repeatability are required. Type J10, being uncalibrated, is smaller and less expensive than Type H9 which is calibrated and has a knob & dial adjustment.

Specs:	
Various Ranges	H9-J10 — between 30" Hg. Vac. and 15 P.S.I.
Switch Differentials	H9 — ½ to 1 ±1/10" W.C. depending upon model. J10 — ¾ to 1 ±3/10" W.C. depending upon model.
Switch Ratings	Standardly 3 amps 115/230 A.C.
Switch Types	N.O., N.C., or Double throw, no neutral position.
Electrical Connections	Made to screw terminals on switches through clearance hole in enclosure.
Pressure Connections	One ¼" NPT pressure connection.
Size	H9 — 7" x 3⅜" dia. J10 — 6⅛" x 3⅜" dia.
Approximate Weight	H9 — 3 lbs. J10 — 2¾ lbs.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Write for complete specification and pricing data on the Types H9 and J10. Similar data available on all other UE controls.*

United Electric Controls COMPANY
85 SCHOOL STREET, WATERTOWN, MASS

For more information circle **43** on inquiry card.

Voltage Comparator

The Model 201-1 DC Voltage Comparator . . . features a chopper input to convert the dc error voltage to an ac signal. Two stages of emitter-follower are next utilized to realize a minimum input impedance of two megohms. The impedance converter drives a three stage transistorized amplifier which in turn feeds into a phase-sensitive diode bridge. The reference frequency signal is utilized in the bridge circuit as a switching voltage. Alternate halves of the reference voltage switch the diodes to a conducting condition, resulting in operation of the bridge within the high conduction region of the diodes. The bridge then efficiently converts ac voltage signals to proportional dc-levels . . . (*From new 2-page Reprint from Nov./Dec., 1958 issue of Military Systems Design, Trio Laboratories, Inc., Plainview, N. Y.*)

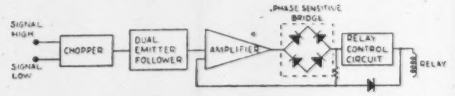


FIG. 2. DC VOLTAGE Comparator block diagram.

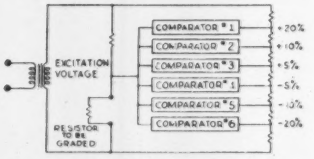
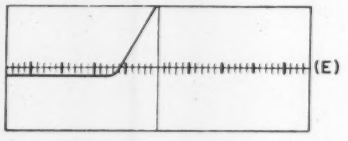


FIG. 3. AUTOMATIC Resistor Grading System, using Trio-Laboratories, Inc., 200 Series Voltage Comparators.

For this literature circle **166** on inquiry card.

Measurement Of Fast Rise Pulses

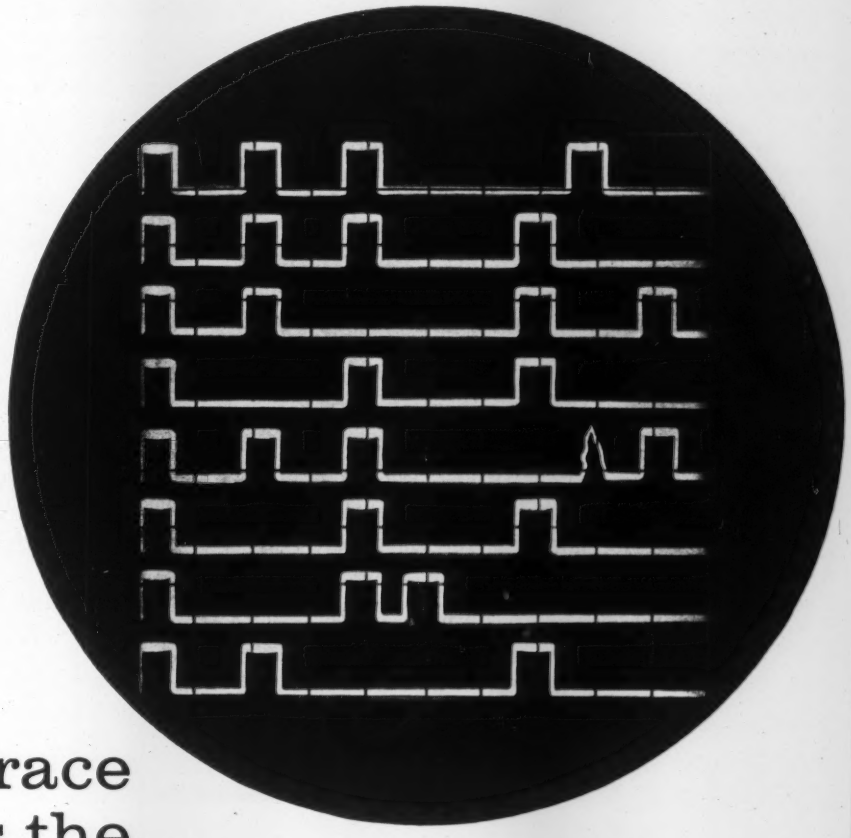
The Du Mont Type 410 oscilloscope is designed for complete quantitative investigations within the range of dc to beyond 50 megacycles . . . As measured on the cathode-ray tube, the Y-amplifier has a rise time of less than 7 millimicroseconds. Its wide frequency range, from dc to beyond 50 megacycles, is down no more than 3 db at 50 mc (referred to mid-band) with a maximum overswing of 2%. . .



A Y-position calibrator permits accurate rise time measurements of any high-frequency display phenomenon that can be positioned with the limits of the scale over the cathode-ray tube screen . . . (*From new 4-page Bulletin "Type 410", Allen B. Du Mont Labs., Inc., Instrument Div., 760 Bloomfield Ave., Clifton, N. J.*)

For this literature circle **167** on inquiry card.

Trace Retention with MEMO-SCOPE recorder. Application No. 2



which trace has the transient?

Data reduction systems have long been plagued by false signals from intermittents and transients—particularly those using digital bits and words. With the MEMO-SCOPE® recorder you can locate this false information with comparative ease.

For example, the above display shows 8 traces—one showing a non-recurrent transient pulse. The MEMO-SCOPE recorder freezes this transient information on the face of the tube until intentionally erased. Therefore, transients can be retained for study, regardless of the fact that they are intermittent in nature and last only a few microseconds. For more information concerning this application, write for Data Sheet MSAD-A2.

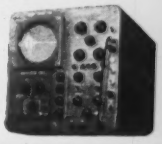
Many unique problems have been solved with the MEMO-SCOPE *recorder through trace retention. Refer your problems to us by writing: Hughes* MEMO-SCOPE *recorder, Hughes Products, International Airport Station, Los Angeles 45, California.*

A new MEMO-SCOPE recorder accessory . . . the **Multitracer** . . . makes it possible for you to automatically program up to 20 different traces on the tube face.

In addition to data reduction trouble shooting, the MEMO-SCOPE recorder makes it possible for you to save time and money in problems associated with:

- *Ultrasonic flaw testing*
- *Drift measurements*
- *Ballistics, explosives research*
- *Switch, relay contact studies*
- *Welding*
- *Transducer testing*
- XY *plotters*
- *Medical diagnosis problems*
- *Physical testing*
- *plus many more*

SPECIFICATIONS:
Sweep Speed for Storage: 10 microseconds per division to 10 seconds per division (0.33").
Frequency Response: DC to 250 KC down 3 db.
Sensitivity: 10 millivolts to 50 volts per division or with optional high sensitivity preamplifier 1 millivolt to 50 volts per division.



Creating a new world with ELECTRONICS **HUGHES PRODUCTS**

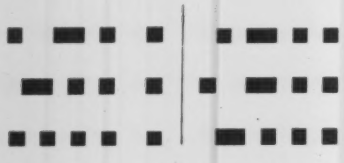
© 1959, HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DEVICES • STORAGE AND MICROWAVE TUBES • CRYSTAL FILTERS • OSCILLOSCOPES • RELAYS • SWITCHES • INDUSTRIAL CONTROL SYSTEMS

For more information circle **44** on inquiry card.

Automatic Carton Selector

The Model 410 is a fully transistorized device for identifying packaged products automatically by reading code markings printed on the product carton . . . As the carton travels along the conveyor line past the Model 410, a Self-Contained Light Source, consisting of a bank of rugged light bulbs, illuminates the area of the carton surface bearing the code marks. Simul-



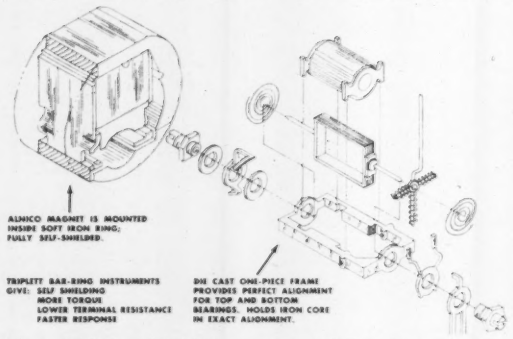
taneously, the reflected light from these code marks is read by ten Photocell Viewers located immediately below the light source. A Recognition Circuit then determines if the code read by the photocell units is identical with the one which has been preset into the unit by the positioning of the toggle switches . . . Thirty-one different codes are available for distinguishing 31 different products. Several codes are illustrated, but only one is required for each carton type . . . (*From new* 4-*page Spec.* 26858, *Atronic Products, Inc., One Bala Ave., Bala-Cynwyd, Penna.*)

For this literature circle **168** on inquiry card.

Bar-Ring Type Movements

The name "Bar-Ring" is derived from the principal parts which make up the magnet and pole piece assembly. The bar magnet is mounted inside the soft iron ring, and is self-shielded by the ring.

The alnico magnet is external to the moving coil, thereby eliminating any restriction on magnet size,

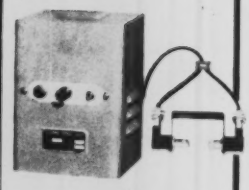

ALNICO MAGNET IS MOUNTED INSIDE SOFT IRON RING; FULLY SELF-SHIELDED.
TRIPLETT BAR-RING INSTRUMENTS GIVE: SELF SHIELDING MORE TORQUE LOWER TERMINAL RESISTANCE FASTER RESPONSE
DIE CAST ONE-PIECE FRAME PROVIDES PERFECT ALIGNMENT FOR TOP AND BOTTOM BEARINGS. HOLDS IRON CORE IN EXACT ALIGNMENT.

and providing a highly concentrated flux for maximum torque and highly sensitive meters. This external magnet design also permits the use of light-weight moving coils when compared to other self-shielded movements. Magnet assemblies (magnet, pole pieces and and soft iron core) are machined and ground to extreme tolerances to insure uniform flux distribution. Thus, scale characteristics are uniform throughout their length . . . (*From new* 2-*page Form* 3159-1, *The Triplett Electrical Instrument Co., Bluffton, Ohio.*)

For this literature circle **169** on inquiry card.

POST DECITRON ELECTRONIC PRODUCTS

Photoelectronic Controls



Model K-1 with Miniature Photohead
This is a general purpose photoelectric control whereby the interruption of a light beam in the photohead closes a relay which can be used to activate an external circuit.

Model K-3
The K-3 control differs from the K-1 in that the output relay will not energize for each interruption of the light beam, but only if interruptions cease. Can be used to detect "flow" stoppage.

Model H-21-C
The compact, long life, *miniature* photohead . . . ideal for mounting in limited space. May be furnished with alignment brackets to insure proper relation of light source and receiver.

Decitron

ELECTRONIC PRODUCTS DIVISION

Post Machinery Co. | 159 Elliott St., Beverly, Mass.

For more information circle **45** on inquiry card.

beyond normal endurance...

GLASSCO **bourdon helix**

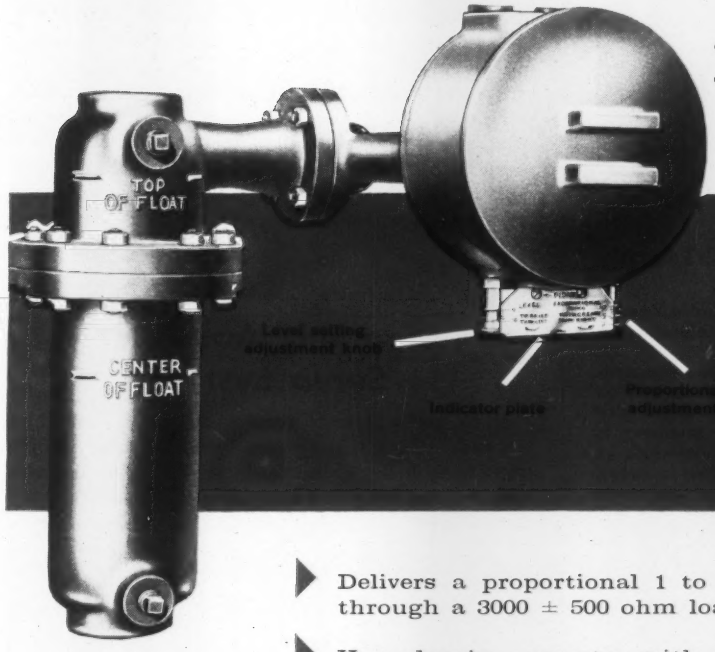
PRESSURE GAUGES PERFORM WITH ACCURACY AND RELIABILITY **BEYOND** ALL PUBLISHED MIL SPECS.

Glassco **Instrument Company**
660 SOUTH FAIR OAKS AVENUE
PASADENA 2, CALIFORNIA

For more information circle **46** on inquiry card.

NOW FISHER LEVEL-TROL®

FOR ELECTRONIC SYSTEMS

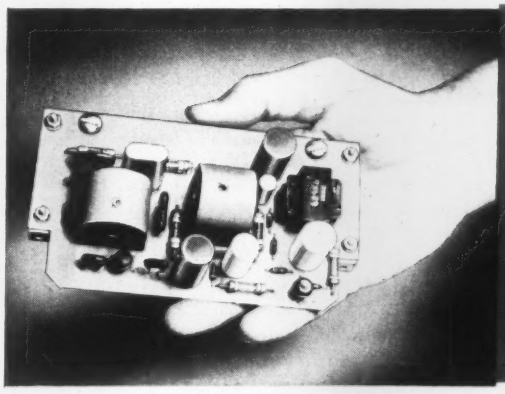


Quick accurate external adjustment

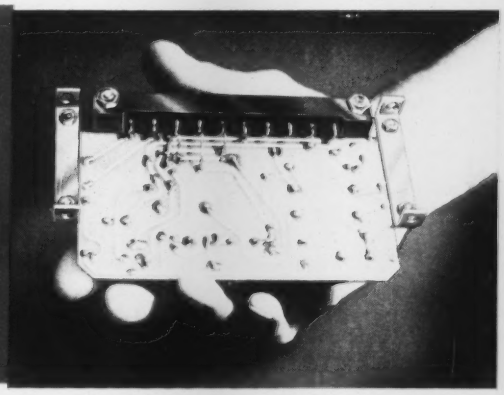
- Delivers a proportional 1 to 5 milliampere dc signal through a 3000 ± 500 ohm load.
- Has plug-in converter with printed circuit. Conventional leads and unnecessary wiring are eliminated.

This Fisher explosion-proof Electronic Level-Trol features external adjustment for proportional band and liquid level height, and incorporates extreme simplicity of design throughout. Silicon transistors and diodes are used instead of the conventional vacuum tubes. You do not need any additional parts to reverse action of the unit. With only .25% effect from ±15% supply voltage change, line voltage fluctuation is of negligible effect.

Fisher Bulletin F-85 will give you complete details on the Fisher Type 2300 Electronic Level-Trol. Send for it.



Plug-in electronic converter assembly.



Printed circuit of the converter assembly.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

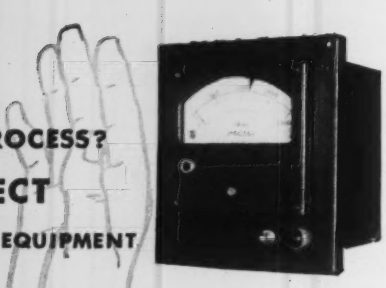
Marshalltown, Iowa Woodstock, Ontario London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER® Controls

SINCE 1880

For more information circle **47** on inquiry card.



HEATING PROCESS?

PROTECT

MATERIAL and EQUIPMENT

Automatically

with Alnor® PYROTAC

Not expensive...but a simple, automatic way to safeguard your investment in heating equipment and materials in process.

The precision-built Pyrotac constantly indicates temperature of the heated equipment and sounds an alarm and/or shuts down the equipment at a safe, preset temperature. May also be used as a controller on processes where shutdown is required upon reaching final process temperature—such as ceramic kilns, molds, etc. Automatic thermocouple break protection assures complete safety if couple or lead wire should break.

Write for Pyrotac bulletin. Attach this ad to your letterhead, send to: Alnor, Room 518, 420 No. LaSalle St, Chicago 10, Ill.

Alnor **PRECISION INSTRUMENTS FOR EVERY INDUSTRY**

For more information circle **48** on inquiry card.

MARSHALLTOWN

DIAPHRAGM GAUGE

FOR ACCURATE PRESSURE MEASUREMENT IN OUNCES OR INCHES OF WATER

Marshalltown Figure 83 is an extremely sensitive gauge that uses a carefully seasoned bronze diaphragm to accurately measure very low pressures. It is used extensively on many types of natural gas installations for checking low pressures.

Available in standard dials (reading in inches of water) 0-15" -0-30" -0-60" -0-100" -0-160" . . . also in ounce graduated dials from 15 ounces to 5 pounds. 2½", 3½" and 4½" dial sizes mounted in black enameled steel case.

Write for details and price. LOOK TO MARSHALLTOWN FOR ONE OF THE MOST COMPLETE LINES OF INDICATING PRESSURE GAUGES MADE!

MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

For more information circle **49** on inquiry card.

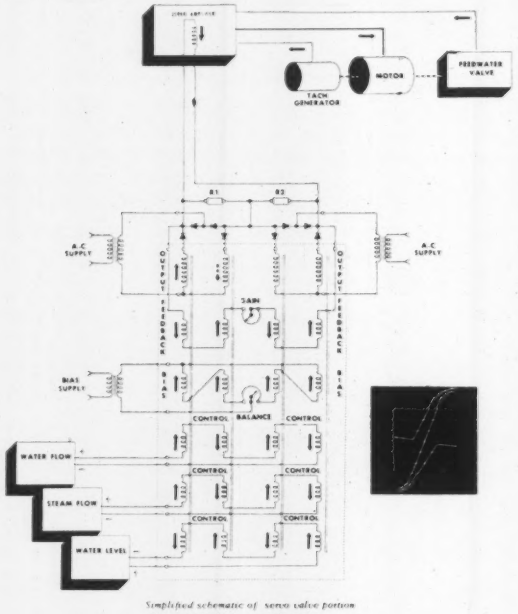
Ultrasonic Soldering

Many new metals and alloys have proved highly resistant to uniting with solder. Although chemical flux used in standard soldering methods ordinarily overcomes this resistance, the flux itself creates additional problems, particularly where corrosion is a critical factor. The new science of soldering and metal coating by ultrasonics—without flux—is a valuable contribution to what is often an extremely complicated operation. SONOSOLDER . . . is an ultrasonic production tool for fluxless soldering and metal coating. . . . (*From new 8-page Bulletin SB-8 which also covers Sonobraze and Sonoweld; Sonobond Corp., West Chester, Penna.*)

For this literature circle **170** on inquiry card.

Magnetic Amplifier Servo System

Many servo systems require high speed and high accuracy. Magnetic amplifiers provide these features together with the additional feature of being the most reliable amplifying means available for the application . . . the servo amplifier is employed in a servo system supplying information to a computer which continuously calculates the data necessary to describe electrically the pitch of a ship in relation to the earth's magnetic fields.



Simplified schematic of servo valve portion of a feedwater boiler control system.

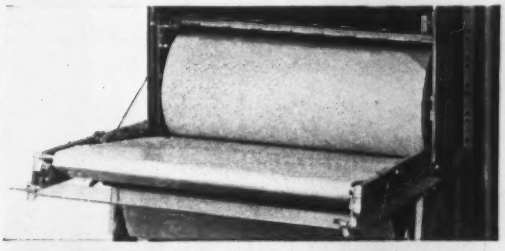
When a difference in angle exists between the rotor of the control transformer and the rotor of the synchro transmitter, an A-C error signal is developed across the rotor of the control transformer and fed into the demodulator. The output of the demodulator is a D-C signal whose magnitude is proportional to the sine of the error angle and whose polarity is a function of the phase of the error signal . . . (*From new 36-page Bulletin* 1105-1, *Vickers Incorporated, Div. of Sperry Rand Corp., Electric Products Div., St. Louis, Mo.*)

For this literature circle **171** on inquiry card.

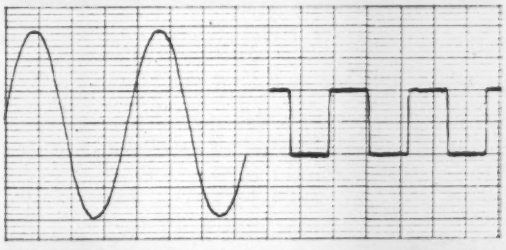
the most versatile . . . most sensitive direct writing unit available!

OFFNER ALL-TRANSISTOR R DYNOGRAPH

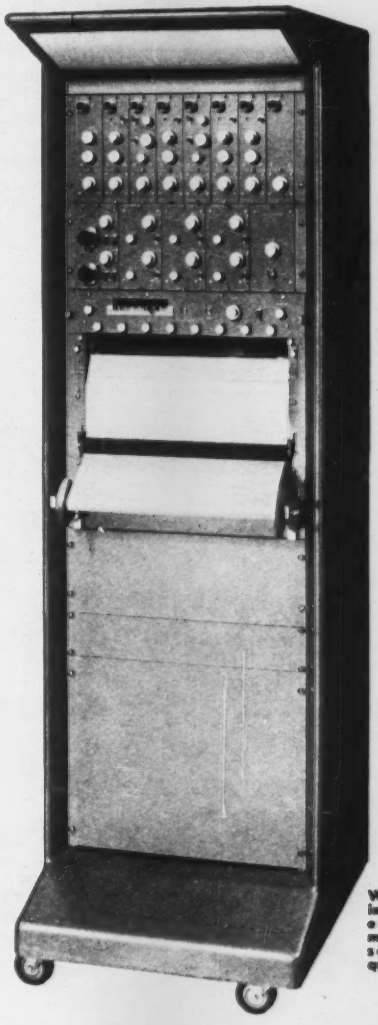
The Type 481 preamplifier, 9800 series input coupler, 482 power amplifier, and 382 power supply are all of plug-in construction. Input is available both front and rear.



The 504A paper drive gives speeds of from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with record fully visible from front.



Full scale, unretouched charts show the extreme sensitivity of the Type R Dynograph. Left—10 microvolt RMS sine wave. Right—10 microvolt D-C square wave. Four recording media. Heat or electric rectilinear—ink or electric curvilinear. Readily convertible.



We have a few openings for highly qualified engineers in development, production, and sales engineering. Inquiries are invited.

all these features... plus 8 channels in only 35″ of rack space

- stable d-c sensitivity of one microvolt per mm
- true differential input
- high input impedance
- response to beyond 150 cps
- reluctance, differential transformer, strain gages with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers
- deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)
- fixed precision calibration
- instant warm-up
- precision source for d-c and 400 cycle excitation, self-contained
- zero suppression, twenty times full scale, both directions

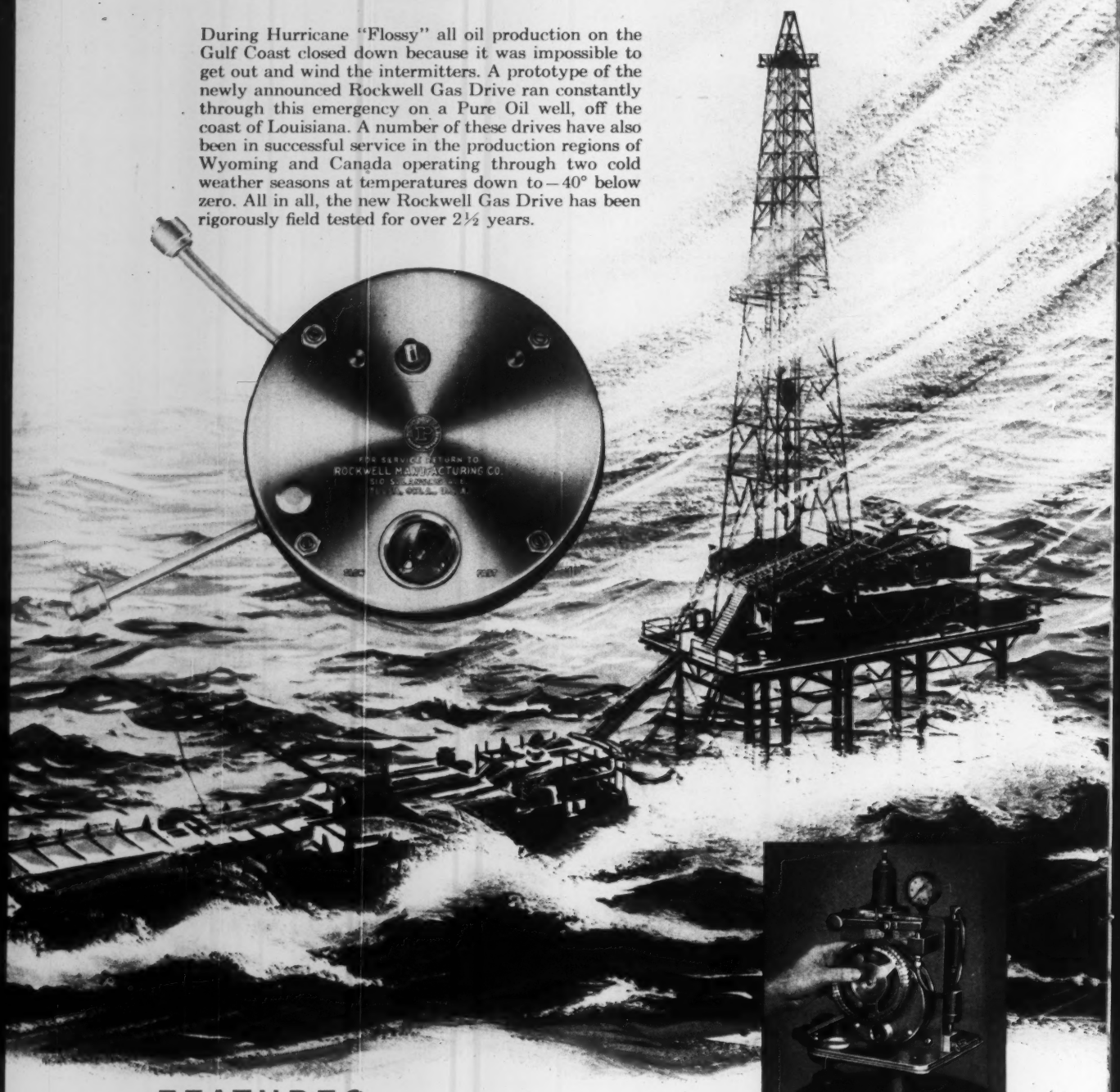
Whatever your application for direct writing records, investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Write on your company letterhead for details and specifications.

OFFNER ELECTRONICS INC. 3910 River Road, Schiller Park, Ill. (Suburb of Chicago)

For more information circle **50** on inquiry card.

The only chart drive that

During Hurricane "Flossy" all oil production on the Gulf Coast closed down because it was impossible to get out and wind the intermitters. A prototype of the newly announced Rockwell Gas Drive ran constantly through this emergency on a Pure Oil well, off the coast of Louisiana. A number of these drives have also been in successful service in the production regions of Wyoming and Canada operating through two cold weather seasons at temperatures down to −40° below zero. All in all, the new Rockwell Gas Drive has been rigorously field tested for over 2½ years.



Rockwell Gas Drive powers this typical transmitter

FEATURES

- **Powered by gas or air—no winding**
- **Built right into a standard Rockwell chart drive case**
- **Adapts to fit practically any instrument without cutting**
- **Uses only 4 cubic feet of gas in 24 hours**
- **Operating pressure range 15-25 psi**

For more information circle **51** on inquiry card.

withstood Hurricane "Flossy"

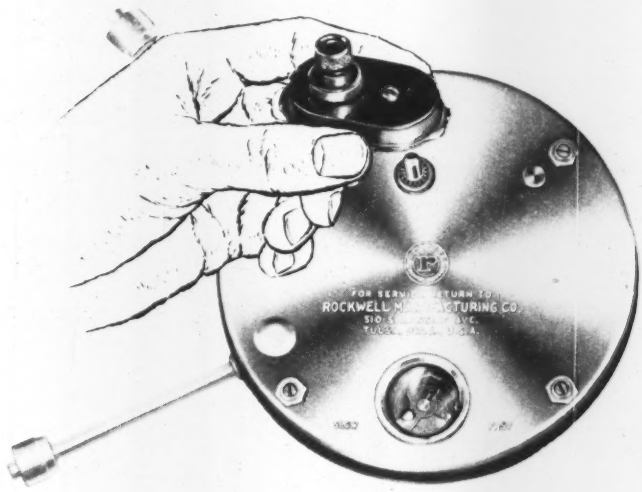
THE NEW ROCKWELL GAS DRIVE

A gas or air powered chart drive for all kinds of recording instruments—completely self-contained, self-starting.

Let's hope you will never need a chart drive that will run throughout a hurricane, but right now you can use the new Rockwell Gas Drive with profit to power remotely located instruments. You can forget the costly chore of periodic winding, for this drive is completely self-powered by the gas (or air) in the flowing stream.

The Rockwell Gas Drive is economical to run—it consumes only 4 cubic feet of gas every day. It's safe, too, for there is no venting problem. And it is built right into the case of a standard Rockwell chart drive and has all the interchangeability features of the spring wound design. It can be neatly fitted into practically any make intermitter, production timing instrument or recorder by using furnished adaptors for position and height. Speed changing turrets, which snap on to the main arbor, provide the utmost versatility in rotation rates. So with a stock of standard Rockwell Gas Drives, plus a selection of economical turrets, you can serve all your instrument needs.

Get full facts by writing Rockwell Manufacturing Company, Instruments Division, Pittsburgh 8, Pa.



The turret on top does the trick.

See how easy it is to convert a Rockwell Gas Drive to any of 10 different rotation rates.

The main arbor on this drive rotates once every 24 hours. Speed changing turrets are available to give 2-hour, 3-hour, 4-hour, 6-hour, 12-hour, 48-hour, 72-hour, 7-day, and 8-day rotation. No special tools or skills are required to convert to different rotation rates; the turrets snap into place.

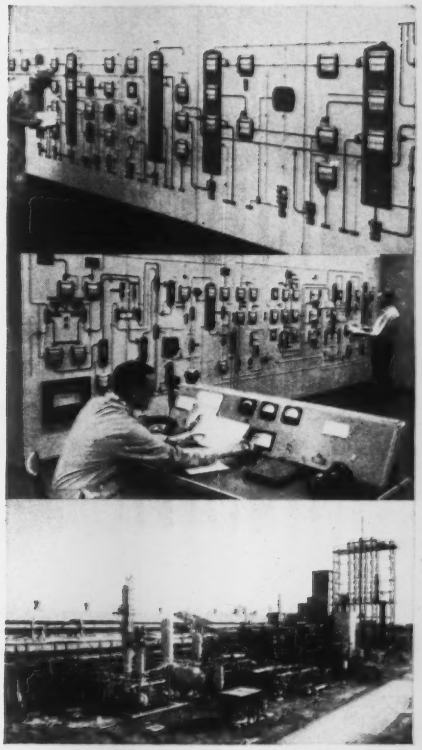
GAS DRIVES, CHART DRIVES

another fine product by

ROCKWELL

For more information circle 51 on inquiry card.

FOXBORO
REG. U.S. PAT. OFF.



Sun Oil Company reports:

"TWO YEARS OPERATION— AND WE HAVEN'T HAD A CONSOTROL* OFF THE PANEL YET"

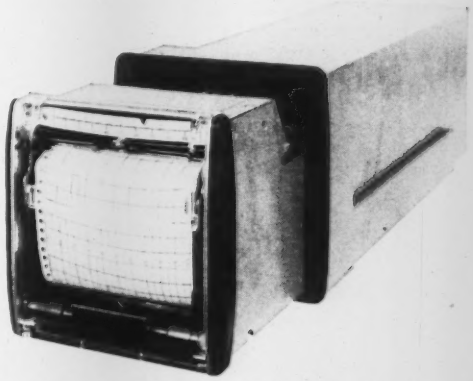
Not only by their unvarying dependability of control, but also through unusual economy of maintenance, Foxboro pneumatic Consotrol Recording Control Stations have proved a profitable investment for Sun Oil Company at Marcus Hook, Penna.

Over two years ago, 129 pneumatic Consotrol instruments were installed as complete instrumentation for the control rooms of the ammonia plant and the Houdriflow catalytic cracking unit in this modern Sun Oil refinery. In continuous operation ever since, not a single Consotrol Recorder or Controller has yet needed recalibration or realignment!

Add to this the fact that Consotrol Recorders need replacement of their full-scale, 4-inch strip charts as infrequently as once a month — re-inking only twice a year — and it's easy to understand why Sun Oil men at Marcus Hook are more than satisfied with Consotrol equipment.

Get the full story of these ultra-dependable Recording-Controllers before you design your next control system. Write for Consotrol Bulletin 13-18. **The Foxboro Company, 466 Norfolk Street, Foxboro, Massachusetts.**

*Reg. U. S. Pat. Off.



Each pneumatic Consotrol Control Station consists of a Recorder with M/58 Controller integrally mounted at rear. Complete station pulls out from front of panel, as shown above.

SHOWN OPPOSITE is part of graphic control panel for cracking unit at Sun Oil Company, Marcus Hook, Penna. All panel instruments were supplied by Foxboro.

CONSOTROL INSTRUMENTS

For more information circle **52** on inquiry card.

AVAILABLE NOW

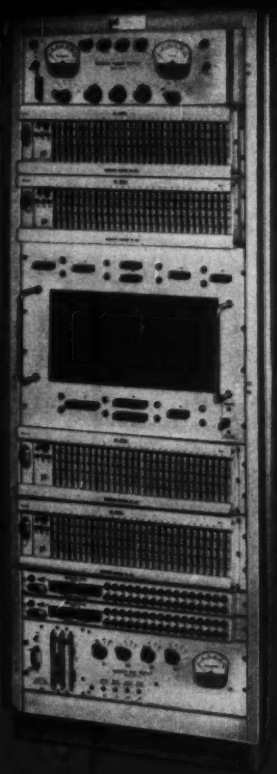
MODULARIZED RANDOM ACCESS MEMORY

COMPUTER CONTROL COMPANY announces the availability of its new all-transistor, coincident current, ferrite core, high speed, random access memory.

FEATURES:

- Word capacities up to 4096 words (you specify).
- Word lengths up to 40 bits/word (you specify).
- Access time to any address — 4 μsec.
- Cycle time — 8 μsec.
- Modular plug-in etched circuits.
- High reliability and ease of maintenance.

Write for eight-page Bulletin TCM



COMPUTER CONTROL COMPANY, INC.

92 SECOND STREET
WELLESLEY 81, MASSACHUSETTS

WESTERN DIVISION
5251 BARRY AVENUE
LOS ANGELES 66, CALIFORNIA

For more information circle **55** on inquiry card.

book reviews

Noise in Electron Devices, by Louis D. Smullin and Hermann A. Haus, [c1959], The Technology Press Massachusetts Institute of Technology and John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 411 p., clothbound, $12.00, 9¼". Stresses mathematical theory and includes traveling-wave tubes, semiconductors, and transistors.

Apparatus and Methods of Oceanography, Part I, Chemical, [c1959], Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 341 p. 5½" x 8½", $5.75. Working text and reference for departments of oceanography and marine biology. Simpler and better-known methods are fully explained, with attention also directed to advanced methods.

Linear Network Analysis, by Sundaram Seshu and Norman Balabanian, [c1959], John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., clothbound, $11.75, 9¼". Starting from Kirchhoff's law the authors develop the foundations of network theory via steady-state and transient response, time and frequency response, and analysis and synthesis.

Electronic Digital Computers, by Charles V. L. Smith, [c1959], McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 443 p., clothbound, $12.00, 9¼". From the parallel direct-coupled asynchronous machine developed at the Institute for Advanced Study to modern superspeed computers the book discusses circuits and components, the performance of memory, control, arithmetic and input-output units, and explains Boolean algebra.

Liquid Scintillation Counting, edited by Carlos G. Bell, Jr. and F. Newton Hayes, [c1958], Pergamon Press Inc., 122 E. 55th St., New York 22, N. Y., 292 p., clothbound $10.00, 9¼". Covers proceedings of conference held at Northwestern University, August 20-22, 1957. Summarizes theory, techniques, and applications of subject matter.

A Guide to Nuclear Energy, by R. F. K. Belchem, [c1957], Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 77 p., clothbound, $3.75 7½". Explains to persons without specialized knowledge theory of nuclear reactions and the manner in which power reactors function.

Continued on page 853

Simplify control problems...

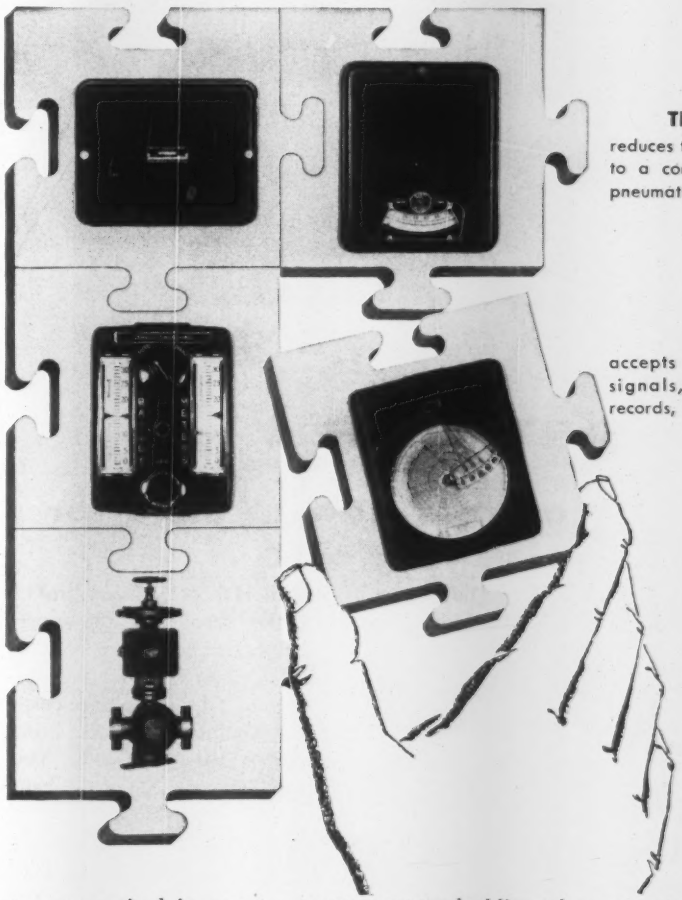
with the Bailey Building Block Method

Control problems are greatly simplified when you attack them using the Bailey Building Block Method. In a nutshell, the method consists of using standard components that fit together like building blocks. Virtually any control requirement can be handled by selecting standard components. Here are the parts you use and the functions they perform.

CONTROL RELAY
takes signals from the transmitter and computes corrective action in terms of pneumatic signals.

SELECTOR STATION
gives operator choice of hand or automatic control including set-point or bias adjustments.

POWER UNIT
Is the "muscle" of the system. It performs whatever precise mechanical action is necessary to achieve control.



TRANSMITTER
reduces the measured variable to a common denominator, a pneumatic or electric signal.

RECEIVER
accepts pneumatic or electric signals, indicates and/or records, measurements.

Not all these components are required in every control system. You buy only what *your* system needs. When you change processes or add more automatic control, you can add additional standard components. Sometimes you may want to build a whole new system, re-using some of the existing components and adding other new ones. Spare parts inventory and maintenance training are reduced.

Hear the complete story of the Bailey Building Block System. Find how it can solve your control problems. See your Bailey Engineer or write for more information. G44-1

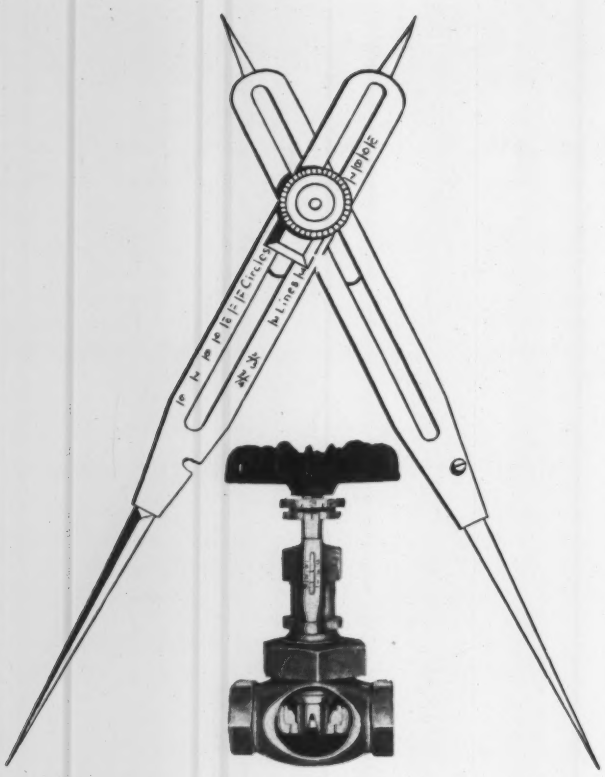
BAILEY METER COMPANY
1041 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

BAILEY BUILDING BLOCK METHOD

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

For more information circle **53** on inquiry card.



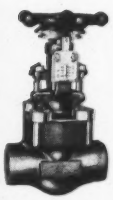
PROPORTIONER

controls flow to save for you

The V-port disc in all Hancock "Flocontrol" Valves insures proportional flow throughout the entire lift of the stem. They are valves that help you achieve uniform product quality through closer control, save steam and fuel on process work, and cut maintenance costs.

"3 in 1" valve design combines variable orifice with shut-off and micrometer dial and pointer. The valve opening can be set within 1/10 turn of the handwheel —you can duplicate all settings easily, instantly. No shut-off valve required—flow is in a straight line, with separate shut-off seating surface located away from the V-ports.

Hancock "Flocontrol" Valves are available in Bronze and Steel to meet the most demanding services. Ask your industrial supply distributor for details.



Hancock "Flocontrol" valves assure positive pinpoint control—eliminate all guesswork.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

HI-88

HANCOCK "FLOCONTROL" VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more information circle **54** on inquiry card.

BOOK REVIEWS—CONT.

101 Ways to Use Your VOM and VTM, by Robert G. Middleton, [c 1959], Howard W. Sams & Co., Inc., Indianapolis 6, Ind., 116 p., paperbound, $2.00, 8½″. Describes and solves service problems.

Automation and Society, edited by Howard Boone Jacobson and Joseph S. Roucek, [c 1959], Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 553 p., clothbound, $10.00, 8½″. Contains 32 non-technical articles by professors and industry leaders, including two Russian authors. Includes glossary of automation.

Theorie der Stabilitaet einer Bewegung (Theory of the Stability of a Motion), by I. G. Malkin, translated from Russian into German by Prof. Dr. W. Hahn and Dr. R. Reisig, R. Oldenbourg Verlag G.m.b.H., Rosenheimer Str. 145, Munich, West Germany, linen-bound, 402 p., DM-47.00.

Symbolic Logic and Intelligent Machines, by Edmund C. Berkeley, [c 1959], Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 203 p., cloth-bound, $6.50. A practical explanation of principles, methods, and purposes of symbolic logic and Boolean algebra.

Switching Circuits and Logical Design, by Samuel H. Caldwell. [c 1958.] John Wiley & Sons, New York 16, N. Y. 686 p. $14. 9¼ in. Based on course at Massachusetts Institute of Technology. Very clearly written. The intent is to prepare the student to create his own methods for handling new problems.

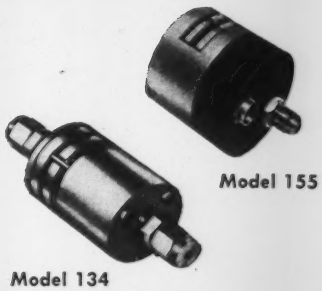
Vibration Control, by John N. Macduff and John R. Curreri. 1958. McGraw-Hill Book Co., New York 36, N. Y. 465 p. $9. 9¼ in. A textbook for advanced students. Presents theory, but deals also with applications, considering mechanical transients (shock), balancing, lateral vibration of shafts, torsional vibration, control of noise, and systems for automatic control.

Analysis of Linear Systems, by David, K. Cheng, 1959, $8.50, Addison-Wesley Publishing Co., Inc., Reading, Mass., 431 plus xiii pages, illustrated, cloth. Introduction to basic calculus, the Laplace transform, Nyquist criteria, the Z transform, and the operational approach to open-loop, closed-loop, and transmission-line systems. Simply and clearly presented at under-graduate university level.

Continued on page 856

PRESSURE TRANSDUCERS

vibration and shock durability



Model 155

Model 134

missile, aircraft, and industrial applications

Features:

- Vibration Durability: 10-25 g's in all axes 10 to 2000 cps
- Infinite resolution conductive plastic potentiometer with wear properties in excess of 20 million cycles
- Repeatability: 0.1 %
- Range: 0-1 to 0-300 psi

RAHM

RAHM INSTRUMENTS

DIV. OF AMERICAN MACHINE AND METALS, INC.

65 Rushmore Street • Westbury, N. Y.

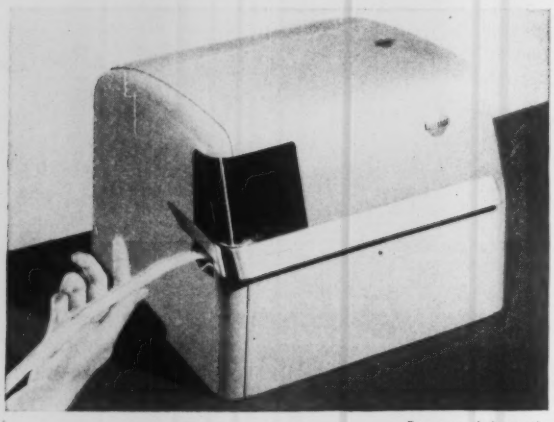
For more information circle **56** on inquiry card.

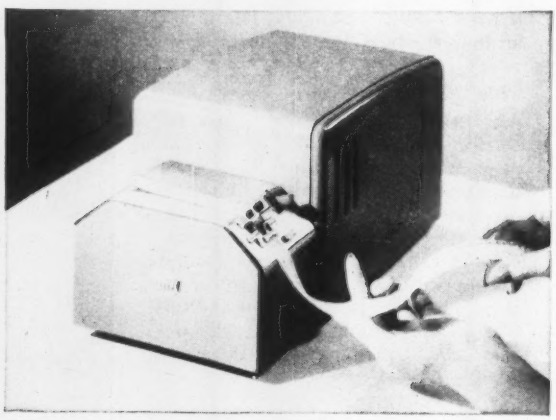
Teletype Model 28 Automatic Send-Receive Set A "complete station" in one console—with facilities for sending and receiving on message paper or sprocket-fed business forms . . . tape punching . . . sending or receiving with tape . . . integrating tape and manual keyboarding . . . producing tape automatically, as a by-product of send-receive operations.

Teletype Model 28 Tape Punch Receives incoming electrical signals, punches a 5-level "common language" tape, and prints data right on the tape, for easy identification and handling. Unit is used for message relaying . . . for integrating data from several sources into a single tape . . . for providing punched tape as a by-product of send-receive operations.

Teletype Model 28 Receive-Only Page Printer A message receiving unit (without keyboard). This is "terminal" equipment, for use where two-way communication is not necessary. No attendant is needed. Produces a printed record on plain paper or multipart business forms. Table models of this unit and the send-receive set at the right are also available.

Teletype Model 28 Tape Reader This is a sending unit. Reads punched tape and instantaneously transmits data to local or remote receiving equipment. As with all Teletype transmitting units, data may go to one destination or a number of destinations simultaneously—either nearby or thousands of miles away.





For more information circle **57** on inquiry card.

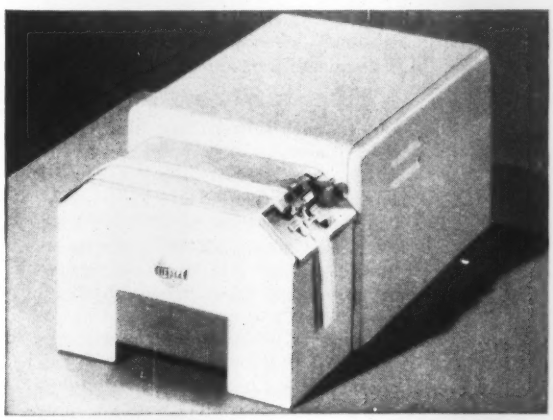
Applications unlimited . . .

TELETYPE Model 28 Line

For communications systems—on-premise or nationwide . . . data handling . . . mechanization . . . automation . . . telemetering.

Teletype Model 28 Send-Receive Page Printer Message originating unit, for sending and receiving. Model 28 page units, including the Automatic Send-Receive Set, feature a built-in "stunt box" control system for automatic station selection and electrical control of remote equipment. Horizontal tabulation and form positioning arrangement available.

Teletype Model 28 Tape Reader—Twin-Shaft Unit is similar to tape reader at left. Besides reading punched tape for on-line transmission, twin-shaft reader-distributor design offers facilities for tape transmission to business machines and direct read-out, from business machines, for on-line transmission.



Presented here are the principal units of the Teletype Model 28 Line. "Model 28" stands for an entirely new concept in record communications. It is an integrated line, designed on the modular principle, permitting a wide choice and ready interchange of components and providing accommodations for expansion. Typebox printing on page units makes possible quick interchange of alpha-numeric characters. Speed is 600 characters per minute with printing, up to 1,200 characters per minute on tape units where printing is not required.

These new machines are manufactured to Teletype's precision standards for continuous day-in and day-out service. Operation is not affected by tilt or vibration. All-steel clutches and simple harmonic design elements reduce and simplify maintenance; oiling is needed only once or twice a year.

Exclusive with the 28 Printer Line is the versatile Stunt Box, which is actually a "robot brain." It responds to keyboard or line signals, and may be used for internal control of extra functions in the Teletype printer and for remote control of Teletype or other electronic or electro-mechanical equipment.

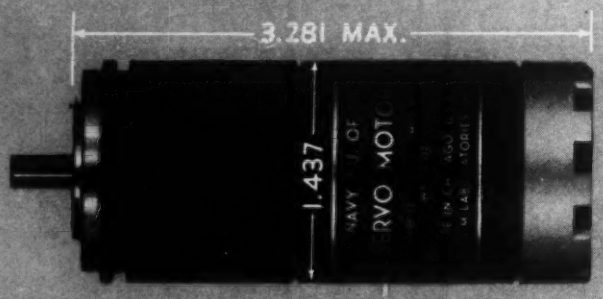
The Teletype Model 28 Line opens new areas of applications in data communications. In addition to the self-contained units shown here, components are available to system manufacturers for integration with their equipment. The tested dependability, accuracy and adaptability of Teletype equipment make it ideally suited for system applications.

More information. If you would like more information on Model 28 equipment or components, please write to: Teletype Corporation, Dept. 23F, 4100 Fullerton Ave., Chicago 39, Illinois.

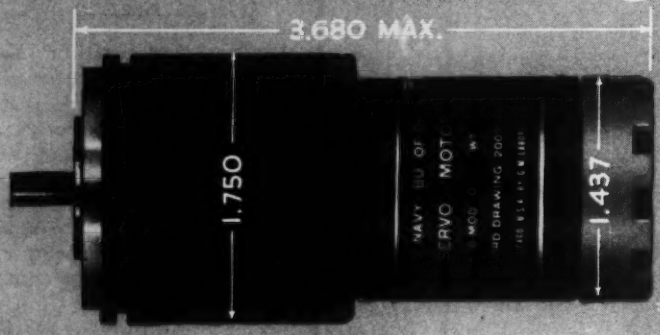
TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

For more information circle **57** on inquiry card.

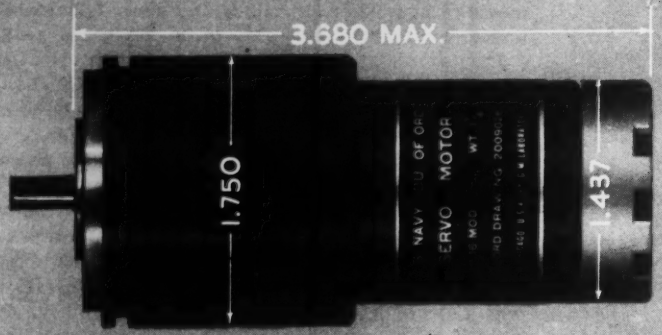
3 More GM Servo Motors



BuOrd Mark 12 Mod 0 SERVO MOTOR Tachometer Generator 115 volts / phase, 4500 RPM (min).



BuOrd Mark 16 Mod 0 SERVO MOTOR Tachometer Generator 115 volts / phase, 4500 RPM (min).



BuOrd Mark 16 Mod 3 SERVO MOTOR Tachometer Generator for transistor operation 115 volts fixed phase 36/18 volts control phase, 4500 RPM (min.)

Built to all applicable Government Specifications—in production... available for prompt delivery.

GM

G-M Servo Motors

manufactured by the Components Division of

G-M LABORATORIES INC.

4316 N. Knox Avenue • Chicago 41

For complete information on these and all SERVO MOTORS, write for G-M PROCUREMENT SPECIFICATION NO. 665.

For more information circle **58** on inquiry card.

BOOK REVIEWS —CONT.

Solid State Magnetic and Dielectric Devices, edited by Harold W. Katz, [c1959] John Wiley & Sons, Inc., 542 p., clothbound, $13.50, 9¼". Book deals mainly with the ferrites and titanates, materials on which information so far has been lacking.

Tube and Semiconductor Selection Guide, 1958-1959 compiled by Th. J. Kroes, second revised edition [c1958], N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland, 160 p., paperbound, $1.50, 9¼". Contains tables of tubes grouped by properties, preferred tubes for new, and existing apparatus, replacement tubes, tube bases and holders; and data of diodes and transistors with cross references. Terms are in English (alphabetically arranged), French, German, and Spanish.

Concise Dictionary of Science, by Frank Gaynor, [c1959]) Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y., 546 p., clothbound, $10.00, 8½". The subtitle lists physics, mathematics, nucleonics, astronomy, and chemistry, but such newer sciences as virology, ensymology, cytogenetics, radio-chemistry, high-energy and solid-state physics are covered as well.

Radioactivity Measuring Instruments, by M. C. Nokes, [c1958], Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y., 75 p., clothbound, $4.75, 8-¾". Gives instructions for making a number of simpler radioactivity measuring instruments.

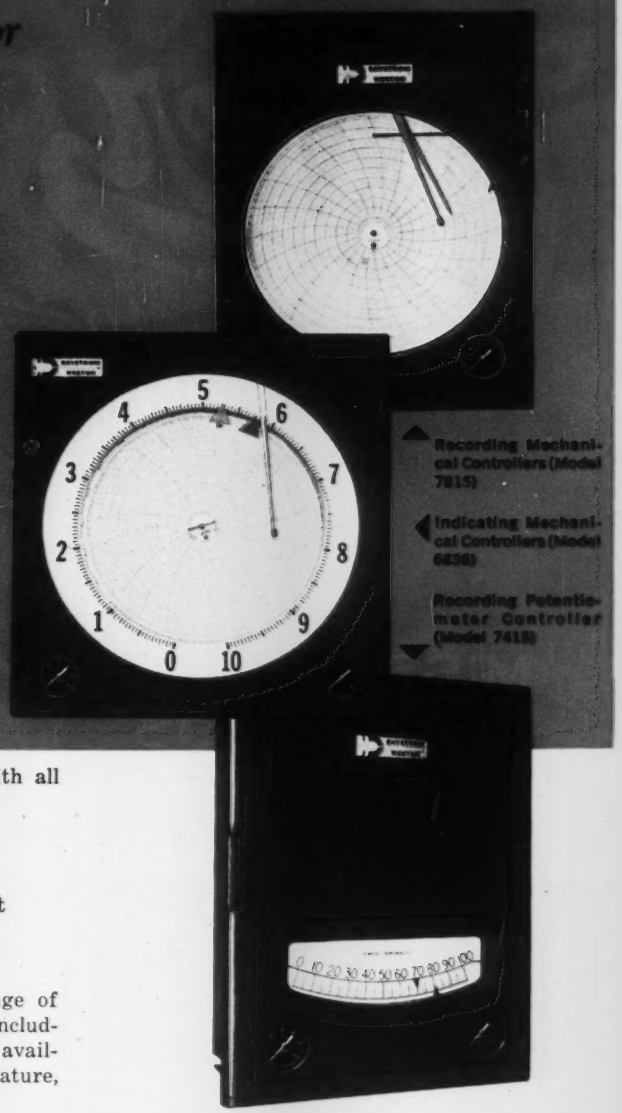
Nuclear Reactors for Power Generation, edited by E. Openshaw Taylor. [1958.] Philosophical Library,, New York 16, N. Y. 144 p. $7.50 8¾in. Contributions by various authors deal with nuclear physics, types of reactor, materials, the physical basis of reactor design, safety, instrumentation, application and economics.

Electronic Scheduling Machine Requirements-PB 121117-43 p-$1.25, and Production Control Through Electronic Data Processing: A Case Study-PB 111580-52p-$1.50, by R. B. Canning, investigates feasability of applying electronic computer technology to shop scheduling—describes ways of applying it, and requirements in equipment and methods. Ordered from OTS, U. S. Department of Commerce, Washington 25, D. C.

When your process calls for

PRECISE, VERSATILE CONTROL

Choose from the DAYSTROM-WESTON complete family of recording and indicating pneumatic controllers


Recording Mechanical Controllers (Model 7815)
Indicating Mechanical Controllers (Model 6836)
Recording Potentiometer Controller (Model 7418)

Each of these advanced instruments is available with all varieties of pneumatic control:

1. Universal: 2-50% proportional band; on-off; and 2-100% differerential gap, manual reset
2. Proportional (2-300%) with automatic reset
3. Proportional (2-300%) with automatic reset plus derivative.

The mechanical instruments cover the complete range of filled thermal systems, pressure spirals and bellows, including pneumatic receivers, interchangeably. Ranges are available as low as —100F. and as high as 1000F. for temperature, and 30" vacuum to 10,000 psi for pressure.

The unitized potentiometer instruments feature plug-in amplifiers, easily interchangeable range standards and slide wires. Constant current is supplied by the D-PAK (T.M.)—Daystrom-Weston's revolutionary solid-state unit which eliminates battery, standard cell, and other standardizing mechanisms.

All models come in dust and moisture-resistant cases and are for universal mounting. They are ruggedly constructed for long life and trouble-free service—and for resistance to vibration and shock. Internal construction is unusually clean in design, and provides easy accessibility to all parts.

For full information, contact your local Weston representative, or write to Daystrom-Weston Sales Division, Newark 12, N.J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N.J.*

DAYSTROM WESTON

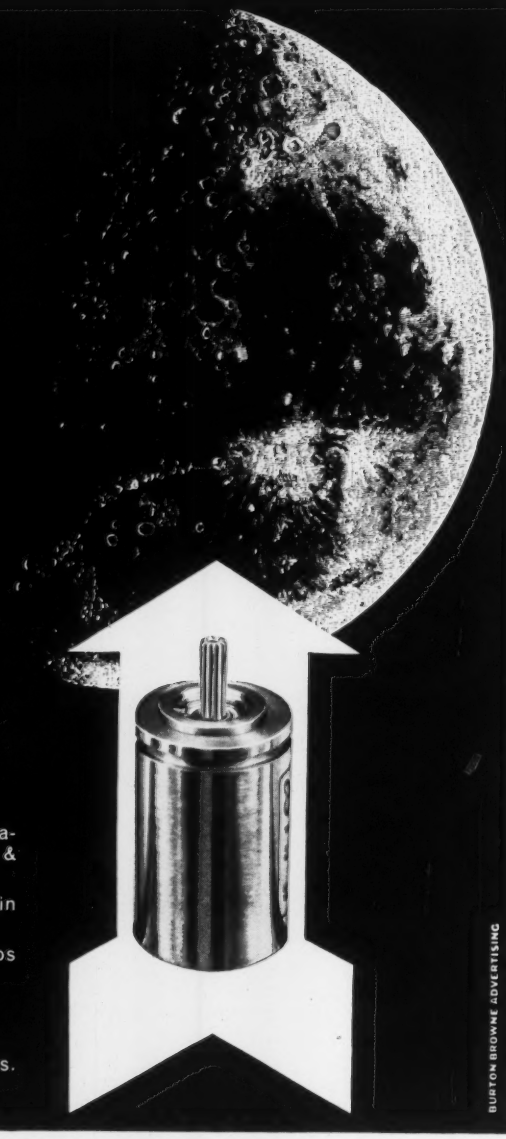
World leader in measurement and control

DAYSTROM-WESTON INDUSTRIAL INSTRUMENTS include a full line of recording and controlling potentiometers with strip and circular charts; mechanical recorders and indicators for pressure, temperature and flow; and non-indicating controllers, both electric and pneumatic.

For more information circle **59** on inquiry card.

Oster®

to the Outside



MISSILE QUALITY SERVOS

For trouble-free systems, missile designers specify Oster reliability. Choose from the Complete Line for Missile, Aircraft & Ground Support Applications.

- Sizes 8, 10, 11, 15, 18, 23, 29 in 400 cycle. Sizes 15, 18, 23 in 60 cycle.
- −55° to +125°C temperature range. Higher temperature servos available for special applications.
- Meet MIL-E-5272A & MIL-E-5400.
- Available with leads & terminals to your requirement.
- Immediate delivery from stock of many types in sample quantities.

BURTON BROWNE ADVERTISING

NEW 24-page SERVO MOTORS CATALOG No. 5000

Lists 40 basic servo types for military, scientific and industrial applications. Write for your free copy on company letterhead today.

OTHER PRODUCTS INCLUDE:

Synchros	Computers
Resolvers	Indicators
Motor Tachs	Servo Mechanisms
DC Motors	Servo Torque Units

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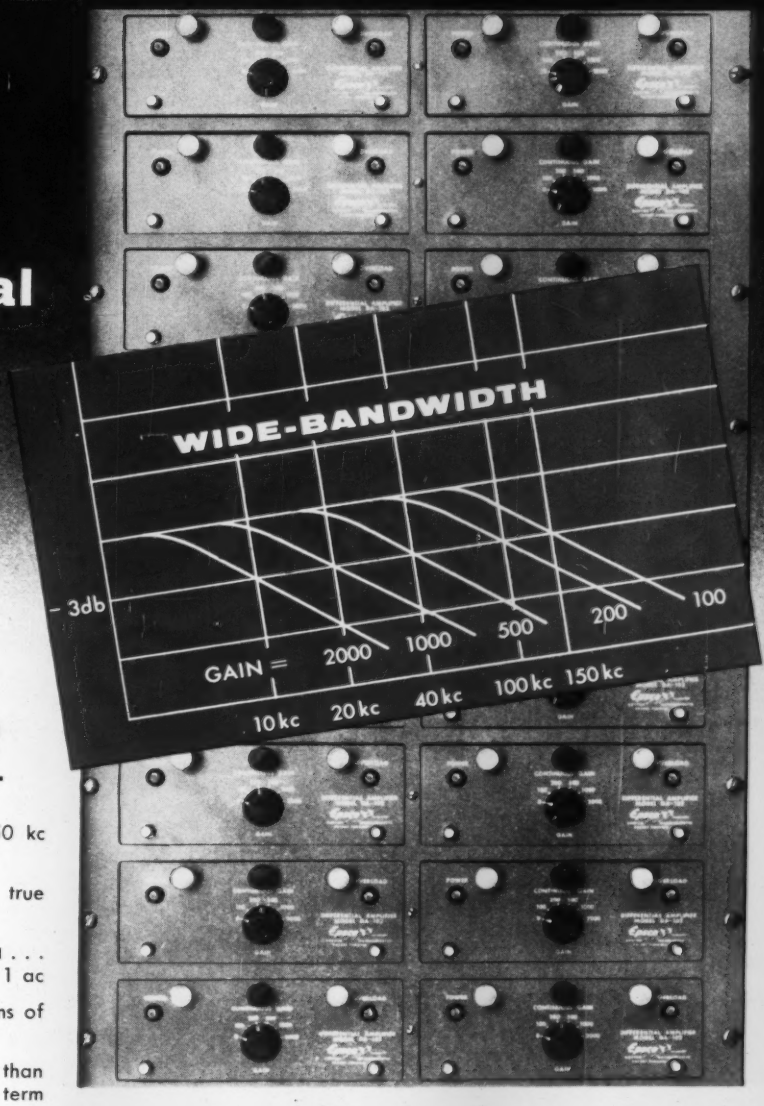
Engineers For Advanced Projects: Interesting, varied work on designing transistor circuits and servo mechanisms. Contact Mr. Robert Burns, Personnel Manager, in confidence.

For more information circle **60** on inquiry card.

Wide Bandwidth with True Differential Input



Only Epsco Instrumentation Amplifiers give you all these features...

- **WIDE BANDWIDTH** . . . dc to 150 kc at gain of 100
- **TRUE DIFFERENTIAL INPUT** . . . true balance, low capacity
- **HIGH COMMON MODE REJECTION** . . . 200,000 to 1 dc . . . 50,000 to 1 ac
- **HIGH GAIN** . . . selectable gains of 100, 200, 500, 1000, 2000
- **HIGH STABILITY** . . . drift less than 2 μv per day; less than 5 μv long term cumulative drift
- **LOW NOISE** . . . less than 3 μv rms to 50 cps
- **HIGH POWER OUTPUT** . . . $\pm$20 volts, up to 40 ma
- **100,000 OHM INPUT IMPEDANCE**
- **FAST RISE TIME** . . . 2.3 μsec. for full scale step input at gain of 100
- **WIDE DYNAMIC RANGE** . . . unsaturating at twice nominal output
- **NO ADJUSTMENTS OR CALIBRATIONS**
- **NO BATTERIES**

With the ever-increasing need for greater accuracy in dynamic instrumentation the demand for an expanding bandwidth in signal amplification becomes more and more urgent. Epsco Instrumentation Amplifiers not only meet the bandwidth challenge, but they also provide true differential input.

Available rack-mounted or in portable units. Write for Bulletin 105801 for complete technical information and options available.

Epsco

First in data control

Epsco, Inc., Instruments & Equipment Division, 588 Commonwealth Avenue, Boston 15, Massachusetts

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Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

CASE HISTORIES

Frequency Time Standard instruments, selected by Smithsonian Institute to clock satellites, are equipped with New Departure ultra-precise ball bearings.

Photos: Courtesy Ernst Norman Laboratories and Bodine Electric Co.

Ultra Precise Ball Bearings Help "Clock" A Satellite!

CUSTOMER PROBLEM:

Require ultra-precise bearing design for Bodine electric motor used in satellite-tracking micro-clock. Bearings must provide uniformly low starting torque, precise location of rotor shaft and minimum maintenance, to help mechanism achieve time determinations to 0.001 second.

SOLUTION:

N/D Sales Engineers studied special bearing requirements, and recommended New Departure ultra-precise ball bearings. These ball bearings measured up to every requirement for micro-clock motors . . . thanks to New Departure's advanced equipment for research, development and production. N/D equipped micro-clocks, selected by the Smithsonian Institute, are operating in a dozen locations around the world right now, keeping track of vital satellite movements . . . to accuracies of one millisecond and better!

If you're manufacturing or designing electric motors for any high precision applications, including instruments, why not call on New Departure? N/D engineering and research facilities are turning out the latest in high precision instrument ball bearings and advanced ball bearing designs. For more information write Department I-6.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

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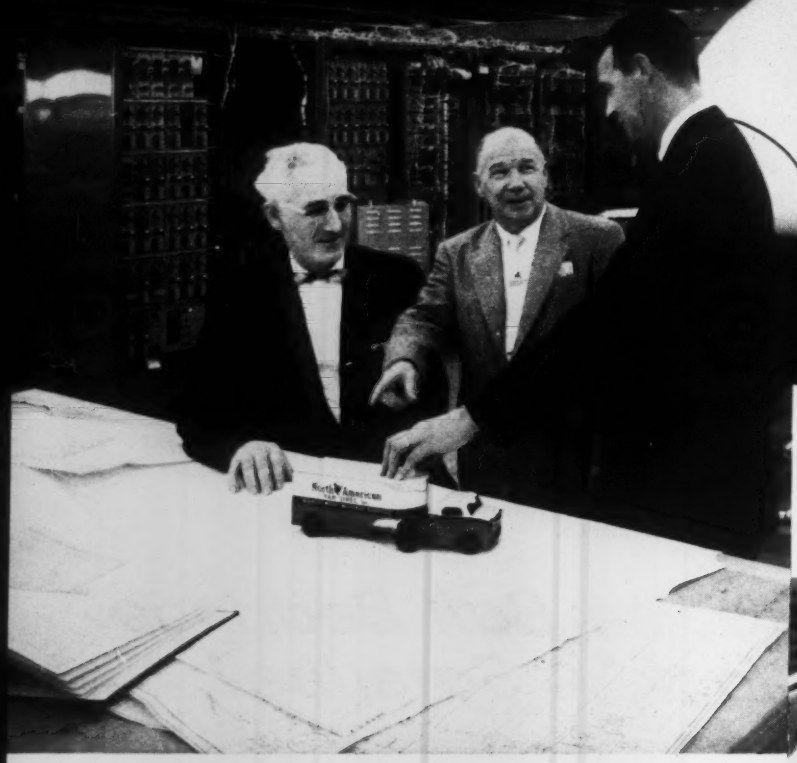
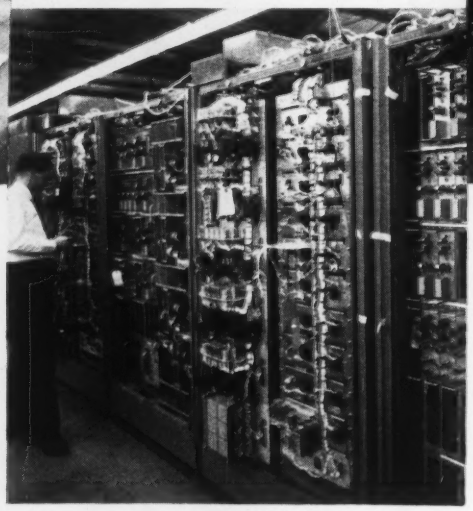
HERE'S PROOF:

North American Van Lines Carries High Value Products

Smoother and Safer



Raymond Jamieson, (center), Traffic Manager of Link Aviation, Inc., Binghamton, N. Y., discusses shipping with NAVL agent and representative. BELOW: Part of the complicated electronic equipment shipped in padded vans.



LINK AVIATION, INC. USES NORTH AMERICAN KID-GLOVE* CARE FOR SHIPPING FLIGHT SIMULATORS UNCRATED

"A $5,000 savings in cost in shipping by padded van over other methods is the bonus we get in delivering a typical flight simulator from Binghamton to the West Coast," says Mr. Jamieson. "With an insured actual value of up to $1,000,000, our primary concern is safe and careful handling. With North American Van Lines, we have never had a claim for damage."

*TRADEMARK

See how you can save with North American service. Write, wire or phone today.

North American
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NORTH AMERICAN VAN LINES, Inc. / World Headquarters / Dept. 18-2 / Fort Wayne, Indiana

In Canada, North American Van Lines Canada, Ltd., Pickering, Ontario . . . in Europe, North American Van Lines Europe, GMBH, Mannheim, Germany

For more information circle **63** on inquiry card.

When you must have recording range out to 150 cps . . . immediately visible, permanent traces in rectangular coordinates . . . a large number of channels in the limited space of a mobile van or control room . . . and the flexibility of a variety of economical preamps—a Sanborn 850 system is the *one* most practical answer to *all* these requirements. In aircraft and missile telemetering facilities, computer installations, test stand work and similar multichannel recording applications, the "850" is proving its unique adaptability and practicality.

You can unplug and change "850" preamplifiers in seconds to record a wide range of variables. Select by pushbutton any of nine electrically-controlled chart speeds from 0.25 mm to 100 /sec. Observe and make notes on the convenient 8" vertical chart display. Reload charts quickly and easily from the front. Every operating feature *you want* is backed up by the performance specifications *you need*—for the greatest possible recording usefulness.

DC Coupling and Phase Sensitive Demodulator preamplifiers are now available. Carrier and Basic Chopper preamplifiers are now being prepared for production. A rack-mounted Master Oscillator Power Amplifier (MOPA) to supply Carrier and Chopper excitation is also in preparation.

THE ONLY 6- or 8-CHANNEL DIRECT WRITER

THAT OFFERS YOU

Response to 150 cps
. . . 0.5% LINEARITY

Wide choice of
ECONOMICAL PREAMPS

INKLESS traces
—RECTANGULAR coordinates

24½" panel space

Your local Sanborn Sales-Engineering representative can give you the complete "850" facts and specifications. Contact him now.

SANBORN COMPANY
Industrial Division
175 Wyman Street Waltham 54, Mass.

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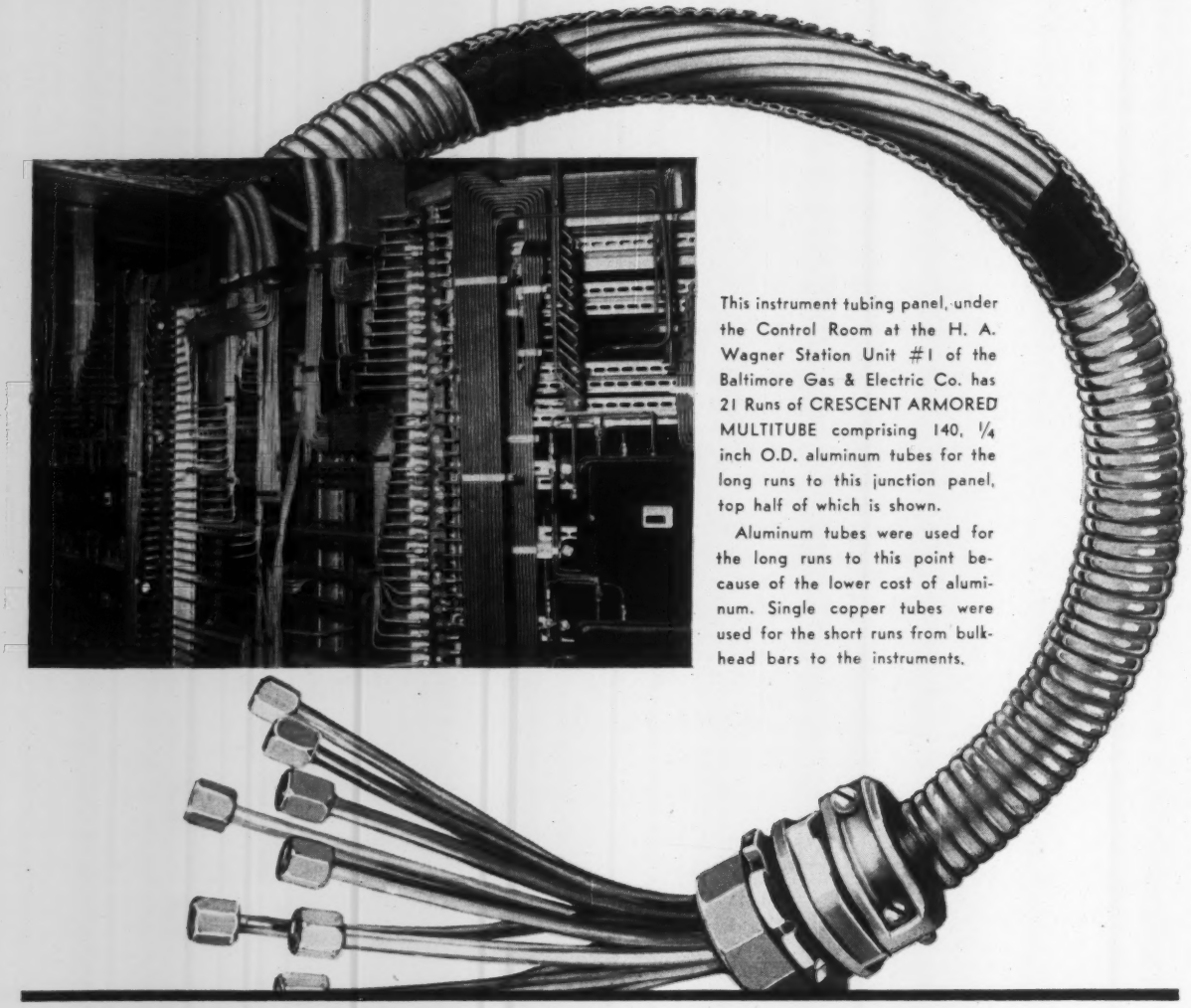
CRESCENT ARMORED MULTITUBE*



This instrument tubing panel, under the Control Room at the H. A. Wagner Station Unit #1 of the Baltimore Gas & Electric Co. has 21 Runs of CRESCENT ARMORED MULTITUBE comprising 140, 1/4 inch O.D. aluminum tubes for the long runs to this junction panel, top half of which is shown.

Aluminum tubes were used for the long runs to this point because of the lower cost of aluminum. Single copper tubes were used for the short runs from bulkhead bars to the instruments.

for dependable performance of instrumentation and control tubing

CRESCENT ARMORED MULTITUBE® is a group of tubes spirally cabled together. One tube in each layer is a bright blue color, which makes identification of any tube at both ends an easy matter.

Users report savings in installed cost of from two to five times the cost of CRESCENT ARMORED MULTITUBE as compared with the old method of using single tubes. Using the MULTITUBE system will result in fewer connections and fittings, lower cost for supports or racks, ease of mounting and less space.

The spiral cabling of the tubes prevents distortion when the entire assembly is bent on a short radius. The tubing assembly is protected by a flexible, interlocked galvanized steel armor, or by a tough corrosion-resistant thermoplastic sheath or both.

Furnished in from 2 to 37 Tubes of copper, aluminum, steel, polyethylene up to 1000 feet. Also special construction for underground runs. This product is licensed under U.S. Patent 2,578,280.

Send for Bulletin 356-D giving complete information and engineering data

CRESCENT INSULATED WIRE & CABLE CO.

TRENTON, NEW JERSEY

* Reg. Trade Mark

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Professional Personnel Requisition

Controls & Instrumentation Engineers

Marquardt Aircraft—a leader in air and space propulsion and control systems, high altitude rocket research and weapon support systems—offers a creative engineering environment in which you will find significant active projects. These include engine control systems for nuclear turbojet, inlet control systems for the North American F-108 and Hound Dog missile, control systems for the supersonic ramjet engine, feasibility studies of advanced and unique engine cycles, nozzle control for advanced ballistic missile components and other power system actuators. These control units include fluid and gas operated servo systems suited for environments above one thousand degrees.

If you are an engineer experienced in fluid dynamics or fluid operated controls and interested in mechanisms designed for severe environmental conditions, you should consider one of the following engineering opportunities at Marquardt:

CONTROLS DESIGN

To create components for pneumatic and hydraulic control systems. Work ranges from simple piston actuators to complex speed computing devices. All designed for high sensitivity, fast response, extreme environmental conditions and light weight. Should be experienced in machine design and have an understanding of basic design analysis.

CONTROLS ANALYSIS

To investigate aircraft and missile control problems through the application of analysis methods in mechanics and dynamics, heat transfer, compressible flow, and servomechanisms. Position offers opportunity for creative engineering.

CONTROLS DEVELOPMENT

Opportunity to create workable controls components. Must have a "feel" for hardware and desire to undertake broad engineering responsibility. Opportunity to solve "on-the-spot" engineering problems utilizing pneumatic and hydraulic control analysis techniques.

ENGINEERING STANDARDS

Implement, establish and/or originate the use of standards both design and hardware for reduction of time and cost of engineering effort. Must have knowledge of hydraulic and pneumatic design and components. Should be capable of setting up an evaluation program as required. Requires ability to work with many engineering groups both in advisory and service capacity.

CONTROL RELIABILITY

To predict reliability of control of units and recommend appropriate design changes. Knowledge of servomechanisms and feedback theory desirable. Should have background in statistics and experience in reliability field.

INSTRUMENTATION

Specification and design of instrument components and systems for ground testing of supersonic ramjet engines, jet engine components, inlet controls, nuclear powerplant controls and emergency power units. Prefer instrumentation experience, including data acquisition and processing equipment. Familiar with process control systems.

For additional information, please write
Mr. Floyd E. Hargiss, Manager
Professional Personnel, Dept. M-2
Marquardt Aircraft Co.
16555 Saticoy Street
Van Nuys, California

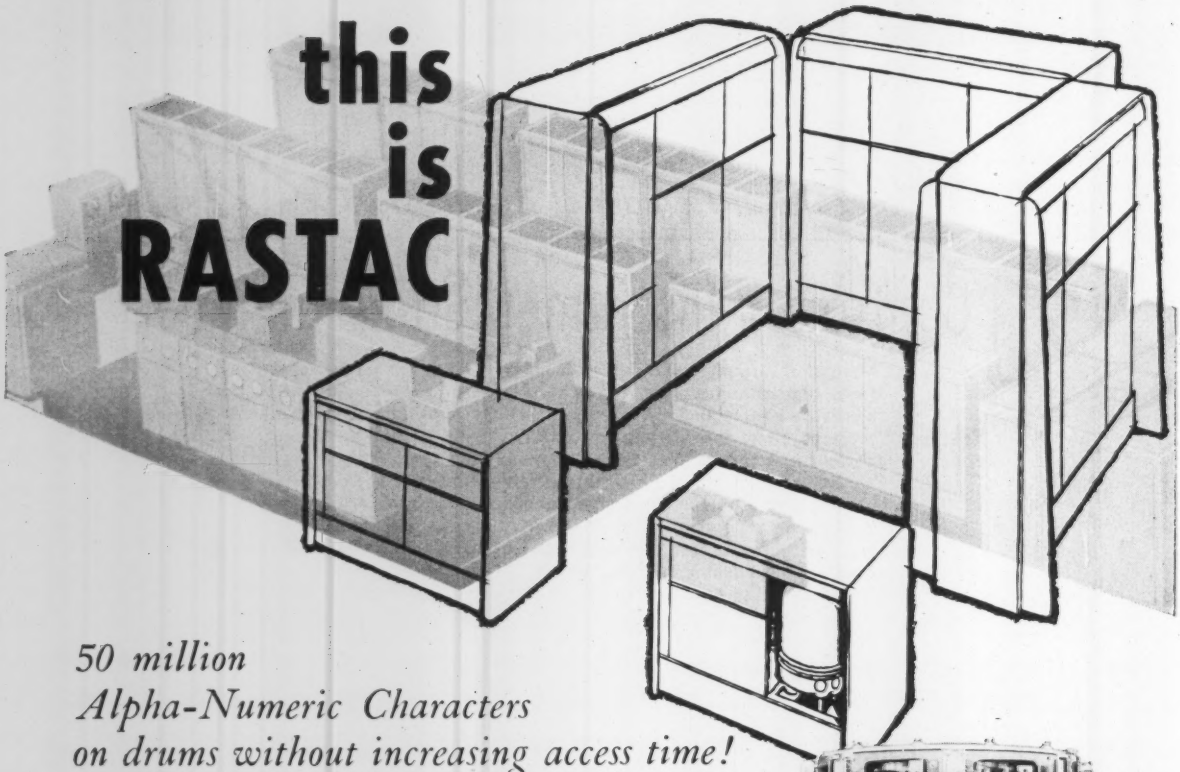
Marquardt AIRCRAFT CO.

VAN NUYS AND POMONA, CALIFORNIA—OGDEN, UTAH

COOPER DEVELOPMENT CORP.—MONROVIA, CALIFORNIA—A MARQUARDT SUBSIDIARY

For more information circle **66** on inquiry card.

this is RASTAC



50 million Alpha-Numeric Characters on drums without increasing access time!

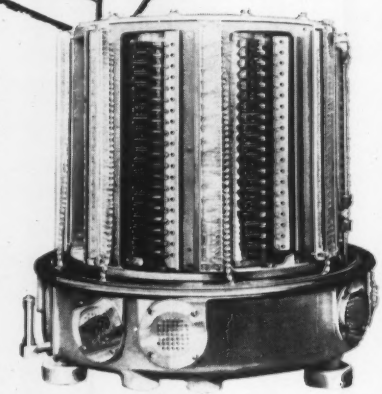
LFE's RASTAC means Random Access Storage and Control in a big way. In general-purpose digital computer applications, it provides mass data storage on an on-line basis. Thus, RASTAC eliminates the "hang-ups" encountered while the computer is searching for data on cards or tape. *Average random access time is only 1/6 of a second, regardless of the size of the system!*

A complete LFE RASTAC System may include from one to thirty-three high density magnetic file drums (LFE Type HD), plus three cabinets of control and power supply elements. So RASTAC is actually a building-block system of reliable magnetic modules.

A RASTAC System can be assembled as a one drum unit with a storage capacity of 1.5 million characters. Or the maximum RASTAC is available with 33 HD drum units for a total storage capacity of almost 50 million characters.

But regardless of the number of drums in use, LFE's RASTAC system always offers an average random access time of 1/6 of a second.

RASTAC is a truly versatile system. In addition to normal on-line operations in conjunction with the Computer, it may also be used independently as a file with the appropriate input and output stations. When used on-line RASTAC may be also equipped with facilities for independent operation during computer down time.



RASTAC can be used in conjunction with any *general purpose digital computer.*

We suggest you consider the RASTAC System if you require fast access to mass data storage. Descriptive literature is available on request. Write to Department C-16

Leadership From Experience

LABORATORY FOR ELECTRONICS, INC.
Computer Products Division
1079 COMMONWEALTH AVENUE, BOSTON

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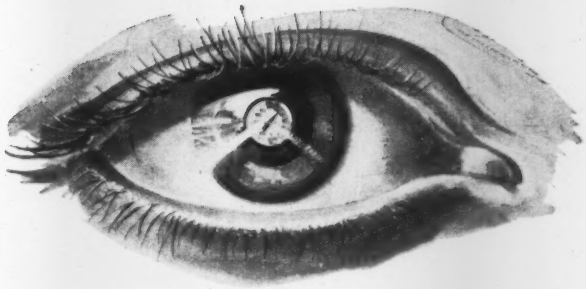

What you read is right

The new, patented Maxivision dial on American Bi-Metal Thermometers eliminates the perspective effect of usual pointer-above-dial construction. No parallax! Readings are sure, sharp and accurate – exact working temperatures are always right before your eyes. It is a two-level dial. A raised outer ring, set close to the cover glass, carries the graduations. The index type pointer is on the same plane as the outer ring, with the numerals on a lower level.

What you read is right when American Bi-Metal Thermometers with anti-parallax Maxivision dial are installed at important check points on your processing facilities. Mounting styles, dial sizes, temperature ranges and stem lengths are available to meet the most exacting requirements. Let your nearby industrial distributor help you select the best combination for each location.

American Bi-Metal Thermometer with Maxivision Dial. Suitable for indoor or outdoor service.

MAXWELL MANNING & MOORE INC. M&M TRADE MARK

A2-58R

AMERICAN INDUSTRIAL THERMOMETERS

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

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FIFTH INTERNATIONAL automation EXPOSITION & CONGRESS

NOVEMBER 16-20 1959

NEW YORK TRADE SHOW BUILDING

THE SHOW

Displays will feature automatic control systems, digital and analog computers, automatic inspection and testing devices, communication systems, feeding and work positioning mechanisms, machine controls, and electronic, electrical, mechanical and electromechanical components.

EXHIBITOR CLINICS

Each morning, exhibiting companies will conduct clinic sessions of 90-minute duration, in front of operating equipments. Clinics will treat these areas of interest: Computers; Process Automation; Machine-tool Automation; Programming; Dimensional Measurement and control; Materials Handling; Office Automation; Temperature, Pressure & Flow Instrumentation; Servomechanisms; Electromechanical Components; and many others.

TECHNICAL SESSIONS

Especially designed for engineers and executives responsible for automation, sessions are planned to cover: Challenge of Measurement and Control; Data Acquisition and Reduction; Automatic Weighing; Control of Machines, Military Electronics and Controls; Medical Instrumentation; Human Factors in Systems Engineering; Plant Layout for Automation; Contribution of Cybernetics; Office Automation For Senior Officers; and Manufacturing and Automation.

COOPERATING SOCIETY

The ASME Materials Handling Division has scheduled four sessions whose theme will be "Materials Handling as a Key to Profit Potentialities in Automation." They include: Automatic Warehousing; Automatic Materials Handling Systems in Process Plants; Management and Economics Problems in Automation; and Systems Engineering.

MILITARY AUTOMATION

The Second Military Automation Show will be held concurrently with the Fifth International Automation Exposition and Congress. Special groupings of electronic and control equipment having application to the military is being arranged. Some sessions will be based on these equipments.

Because the Fifth International Automation Exposition and Congress is principally an educational endeavor, the show management has again selected the New York Trade Show Building as its "ideal" New York Schoolhouse. You'll find the combination of technical sessions, clinic classes and new products exhibited your most rewarding "show" experience of the year.

Richard Rimbach Associates, Management

FIFTH INTERNATIONAL AUTOMATION EXPOSITION

845 Ridge Avenue, Pittsburgh 12, Penna. Phone FAirfax 1-9831 and 1-9832

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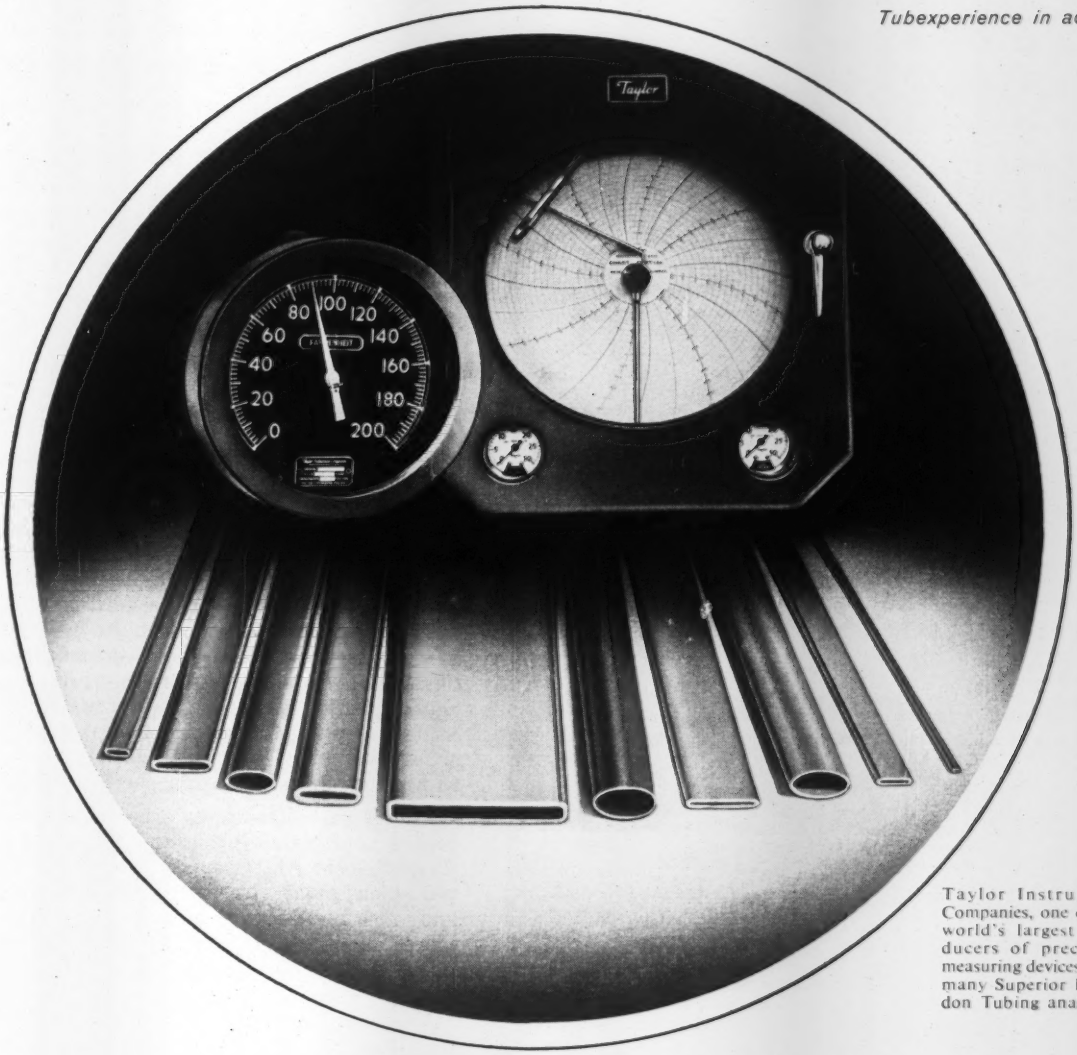


Taylor Instrument Companies, one of the world's largest producers of precision measuring devices, uses many Superior Bourdon Tubing analyses.

R for accurate indication of pressure and temperature: Bourdon Tubing by Superior

Bourdon tubes with consistent spring rate and minimum set, drift and hysteresis are essential to precision measurement of pressure in modern indicating, recording and controlling instruments. The tubing from which they are made must be free of inclusions and seams, carburization or decarburization, rough or corroded surfaces, and variations in wall thickness. Superior Bourdon Tubing has the extra qualities that permit interchangeability of Bourdon elements in the field with maximum ease, simplify range changes, require only linkage adjustment.

Typical of the care exercised in the manufacture of Superior Bourdon Tubing is the use of weight control to check tubing dimensions. This fast, precision method of checking average wall or ID enables us to provide tubing with unusually high overall uniformity. No matter how many Bourdon elements you make from Superior tubing, you get a uniform deflection rate in every case.

Superior offers a wide range of analyses, including strain-hardened, precipitation-hardened and heat-treatable materials for the fabrication of Bourdon Tube elements. Write for a copy of Bulletin 41, giving detailed information. Write Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

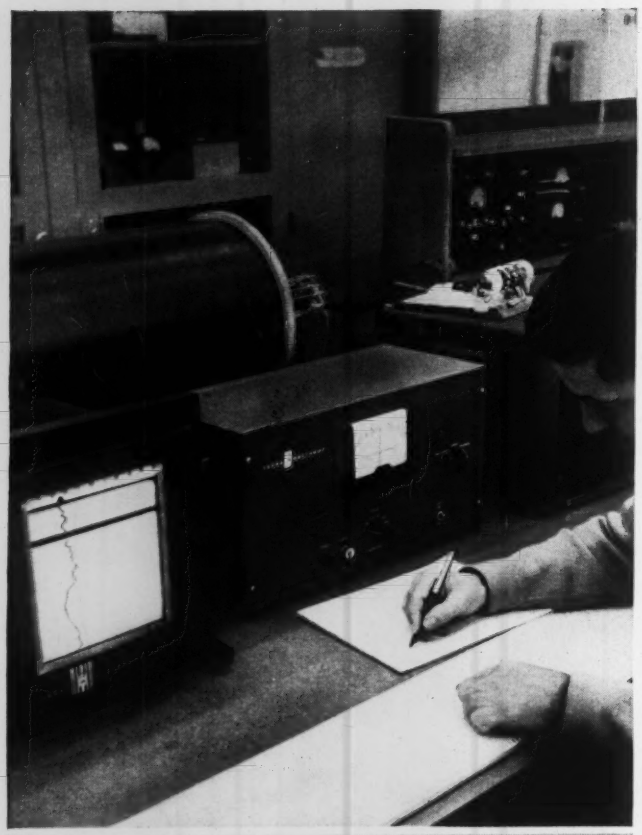
The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

For more information circle **70** on inquiry card.



SPEEDOMAX® H

...the key to highly dependable tests at AMP Incorporated's research lab

Investigation of thermals generated by terminals under high ambient temperatures is one application of Speedomax H instruments in the research laboratories of Aircraft-Marine Products, Inc., Harrisburg, Pa. A Speedomax H Recorder, out of view to the right of the operator, records the 1000 F temperature of the furnace in which the terminals are being heated. An L&N Stabilized Preamplifier with a Speedomax H zero-center millivolt recorder plots the thermals generated by these terminals. Continuous operation without instrument failure (the average test runs about 240 hours) and reproducibility of tests within 1 μv are two advantages of this equipment.

In this same laboratory where new and improved products are being developed and tested to supplement AMP's wide variety of terminals, connectors, plugs, etc., for the electronic, aircraft and other industries, a Speedomax H 2-action D.A.T. Controller is used. This instrument precisely regulates the temperature of an electric batch-type furnace to within ±2 F. The flexibility of this control helps them meet a variety of test conditions in investigating the effects of heat on various connector insulation materials. The instrument's manual rate of approach dial brings the test material up to working temperature in the shortest possible time without overshoot. It also permits rapid recovery of the test temperature when the sample or the control point is changed.

In many research applications where temperatures, pH, voltage, speed, etc., are being studied, a Speedomax H Recorder or Controller can fill your requirements for a high quality instrument that saves bench space, is low in cost and is available for quick delivery (two to four weeks after order is received). For more information, write to Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa., for Data Sheets ND46-33(100-106).

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

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editorial

The Pendulum

AN ARTICLE in this issue ("Instrument Prices Are Not High," by H. Gorrie of Bailey Meter Co.) portrays clearly the dilemma that the instrument manufacturer now faces with regard to systems engineering. The article shows the many hidden and unappreciated costs that must be covered by the catalog price of an instrument, and then it shows in detail the many additional charges that enter into a "systems" job.

These costs are so many, so large, and so variable, that one wonders why an instrument manufacturer would even consider a systems job. This question is answered in Mr. Gorrie's concluding sentence —"There is an increasing tendency on the part of users to demand that the instrument manufacturer do engineering work that traditionally has been done by the user."

The article clearly established the points,—(1) systems work involves consulting-type supervisory functions related to the entire plant layout, primary equipment operation and products of competitors, (2) the responsibility for this work can be in the hands of the user, a consulting engineer, or an instrument manufacturer, but (3) systems engineering is a costly procedure which must be followed in the application of modern instrumentation and which must be paid for either in overhead costs to the user, consulting fees to a consulting engineer, or engineering charges to an instrument manufacturer.

The instrument manufacturers are ready, willing and able to do systems engineering, their concern being—(1) that they be adequately compensated for the engineering involved, and (2) that users and consulting engineers staff themselves with personnel qualified to cooperate in the joint effort to initially install, maintain, and fully utilize a complex system.

Note how the pendulum has swung. In the beginning (1930-40), the instrument manufacturer had to sell his instruments to an industry that had few instruments and fewer instrument specialists. Selling costs were correspondingly high, and volume low. As the volume of instruments grew (1940-1950), industry realized the need for instrument specialists and, today, no plant or factory is without its group of instrument specialists.

But as the complexity of the control loops increased to include initial simulation plus eventual computer control, the instrument industry again faces an industry without the specialists required for the new techniques, and again must supply these services. But the pendulum will not stop.

Simulation

THE power of simulation has been emphasized editorially for more than four years in *INSTRUMENTS AND CONTROL SYSTEMS*. Simulation is the direct instrumental technique for obtaining the critical inter-relationships between process variables, the prerequisite to computer control and systems engineering. A partial list of process applications of the analog computer to date include control system design, components design, process control and optimization, distillation column optimization, process dynamics analysis, heat exchanger control, continuous flow reactor control, multi-component fractional calculations, oil production and recovery analysis, heat and mass flow analysis, pipeline flows, and many others.

The list of applications in mathematics, thermohydrodynamics, aircraft, missiles, automotive fields, marine engineering, electrical and electronic fields, etc., is even longer than in the process field.

A partial list of references of materials on the subject of simulation, which appeared in *INSTRUMENTS* is as follows:

1-50. Monthly Simulation Council Newsletter, appearing in every issue of INSTRUMENTS since April, 1955, and covering all aspects of simulation.

51. A Practical Approach to Analog Computers, John Strong, April 1955, page 602.
52. Editorial "Simulation Councils, Electronic Computers and You," Nov. 1955, page 1846.
53. Editorial, "Automation, Revolution and Insight via Analog Computers," Feb. 1956, page 257.
54. Basic Applications of Analog Computers, P. J. Herman, K. H. Starks, J. A. Rudolph, March 1956, page 464.
55. Process Control and the Analog Computer, J. H. Hussey, October 1956, page 2001.
56. Industrial Uses of Special Purpose Computers, A. H. Kuhnel, July 1955, page 1108.
57. Computer Control of a Rolling Mill Schedule, A. H. Kuhnel, July 1956, page 1303.
58. Process Control Analysis, M. H. LaJoy, E. A. Baillif, April 1955, page 617.
59. Industrial Uses of Analog Computers, R. H. Hovious, C. D. Morrill, N. P. Tomlinson, April 1955, page 594.
60. Computers in the Process Industries, T. J. Williams, R. C. Johnson, A. Rose, Jan. 1958, page 90.
61. Computer Designed Rolling Mill, February 1958, page 283.
62. Simulation of a Solvent Recovery Process, C. Worley, April 1958, page 648.
63. Distillation Column Dynamic Characteristics, August 1958, page 1357.
64. What Price Computer Reliability? S. Rogers and J. McLeod, June 1958, page 1039.
65. Simulation, June 1958, page 1043.
66. Computer Handbook, Vol. 2, Instruments Publishing Co.

Also in preparation for you are articles "The EDA," by J. McLeod and "Tubular Reactor Simulation," by C. Worley.

INSTRUMENTS AND CONTROL SYSTEMS welcomes another important addition to the field of analog simulation—a small, transistorized desk-size analog computer, the PACE TR-10, a 10-amplifier basic model designed for the individual engineer. It is described and illustrated on page 918 of this issue.

Instrument Prices Are Not High

The catalog price for an instrument is very low, considering the hidden costs for quality, reliability, parts, selling, application engineering, R&D, and "specials." But now the manufacturer faces a new development that requires careful pricing—systems engineering.

H. H. GORRIE
Vice President, Engineering
Bailey Meter Company

IT IS NOT uncommon in industry to use a $200 controller to control a $10,000,000 process. This places heavy responsibility on the instrument manufacturer. It means careful design, extensive product testing, comprehensive quality control prodecures, precise manufacturing techniques, and selection of highest quality materials to guarantee accuracy and reliability.

The instrument also is expected to last as long as the primary equipment to which it is applied, which may be 40 years or more, and the manufacturer is expected to supply replacement parts throughout the life of the equipment.

The instrument manufacturer also must invest heavily in research and development, and the instrument industry is presently spending twice as much of its sales dollar on research and development as does the average U. S. industry. This cannot be decreased if we are to keep pace with changing technology and industry requirements.

The instrument manufacturer also faces an increasing demand for service in areas such as application engineering, process simulation or computer analysis, customer training, and specific application and operation instructions. He often must provide qualified field service engineers and technicians for supervision of installation and start-up.

The instrument manufacturer also offers many special, accommodation, and custom products, often in the hope that its cost will be offset by a large volume of related standard equipment. (Too often a competitor gets the order for all standard equipment, leaving the developer holding the bag—and the costs—for the special item.)

All these factors—quality, reliability, life, parts, selling and application costs, R&D, and "specials"—are expensive, and are today reflected in the catalog prices of an instrument. But now the manufacturer faces another development which he must price very carefully—systems engineering.

Abstracts from a talk given before Boston Section, ISA, December, 1958.

Systems Engineering

Systems involve the integration of products with application know-how into a custom-built assembly to satisfy a specific application. It may be done by the user or by the instrument manufacturer or, more likely, partly by each.

It involves a type of work that previously was the responsibility of the user. It is important that both the user and the manufacturer recognize the shift in man-hours from the user to the instrument manufacturer to do systems engineering.

This shift in man-hours obviously involves the man-hours required to engineer the system and to convert equipment specifications into manufacturing information. However it is not generally appreciated by the user that the work of *integrating* all phases of the job is also transferred to the instrument manufacturer.

For example:

1. Purchase other manufacturers' equipment necessary to complete the installation.
2. Prepare shop diagrams to interconnect other manufacturers' equipment.
3. Schedule and expedite the entire job including obtaining and solidifying the specifications.
4. Establish a constant line of communication for drawing approval, equipment changes, installation requirements, etc.

There is evidence that some instrument manufacturers do not recognize the implications involved in such a transfer of work. There are outstanding differences between product engineering and systems engineering, particularly in the extra man-hours of highly skilled personnel involved in systems engineering.

Analysis of a systems job involves engineering costs in these areas:

Estimating the job, prior to sale
Solidifying the specifications
Engineering the system
Processing changes in specifications
Scheduling and expediting
Responsibility after shipment

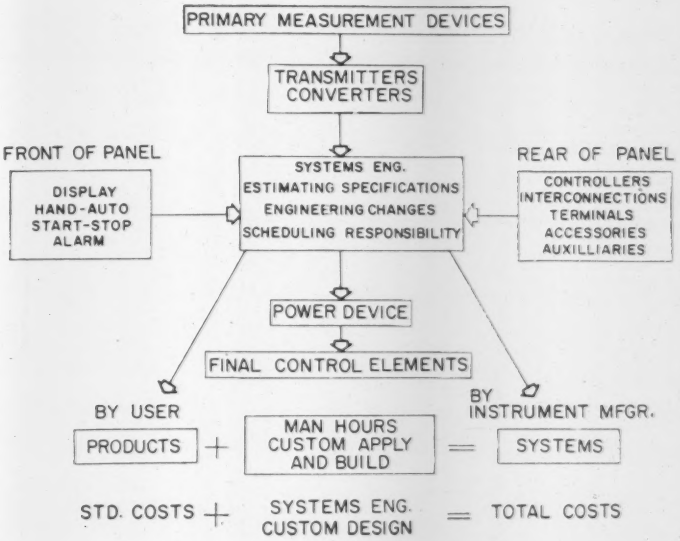

PRIMARY MEASUREMENT DEVICES
TRANSMITTERS CONVERTERS
FRONT OF PANEL
DISPLAY HAND-AUTO START-STOP ALARM
SYSTEMS ENG. ESTIMATING SPECIFICATIONS ENGINEERING CHANGES SCHEDULING RESPONSIBILITY
REAR OF PANEL
CONTROLLERS INTERCONNECTIONS TERMINALS ACCESSORIES AUXILLIARIES
POWER DEVICE
FINAL CONTROL ELEMENTS
BY USER
BY INSTRUMENT MFGR.
PRODUCTS + MAN HOURS CUSTOM APPLY AND BUILD = SYSTEMS
STD. COSTS + SYSTEMS ENG. CUSTOM DESIGN = TOTAL COSTS

FIG. 1. ESTIMATING a systems job is a complex procedure.

The following applies specifically to a systems job in which the instrument manufacturer does all the systems engineering.

Estimating the Job Prior to Sale

Estimating a systems job is a complex procedure. It can be divided, roughly into three areas:

1. What is the objective of the system? What measurements must be made? What factors must be controlled? What safety features must be provided?

2. What economics must be considered? Will there be savings in fuel? An improved product? A greater yield? Etc.

3. The answer to questions 1 and 2 should result in a block diagram from which the final proposal can be developed as follows:

(a) Obtain prices on equipment not made by the instrument manufacturer.

(b) Prepare drawings showing alternate display arrangements.

(c) Prepare functional diagrams of systems operation.

(d) Obtain estimates on specially designed equipment required specifically for the installation.

(e) If a simulation study of the process and control system is required to determine the correct instrumentation, block out the scope of simulation study and estimate its cost.

Solidifying the Specifications

Systems jobs are in many cases awarded to a specific instrument manufacturer largely upon the manufacturer's know-how and reputation in the field, rather than upon the exact details of his proposal.

This means that the first step after the contract has been awarded is to develop the detailed job specifications. This includes the following:

1. Establish equipment ranges, capacities, sizes, power requirements, locations, etc.

2. Finalize function diagrams or schematics depicting systems application and operation.

3. Finalize control room arrangement, operating panel or cabinet location, etc.

4. Obtain specifications for ordering other manufacturers' equipment or obtain a list of equipment which will be supplied by the user for panel or cabinet mounting.

In short, this phase of the operation sets the stage for proceeding with the detailed engineering of systems and equipment.

This is normally one of the most time-consuming phases of systems job and is responsible for more delayed shipments than any other single factor. This is probably true because this phase of the work is an area of undefined responsibility, because many people are involved, and because this is an operation of interchange of information rather than of simple procurement of information.

It is further complicated by: (a) The interrelation between the primary plant engineering and system engineering. The lead time in complex instrumentation systems is quite long and the situation must be anticipated. (b) Information often does not flow smoothly because of a shortage of user manpower to approve drawings and equipment specifications, gather primary equipment operating information, clear installation details, etc. (c) Complicated paths of communication often involve ultimate user plant and home office, consulting engineer, instrument manufacturer home office, and district office or offices.

Engineering the System

The detailed engineering of the system and its components is done in this phase of operations. Here the translation from equipment specifications to manufacturing information, from functional diagrams to detailed connection diagrams, and from pictorial panel or cabinet presentations to manu-

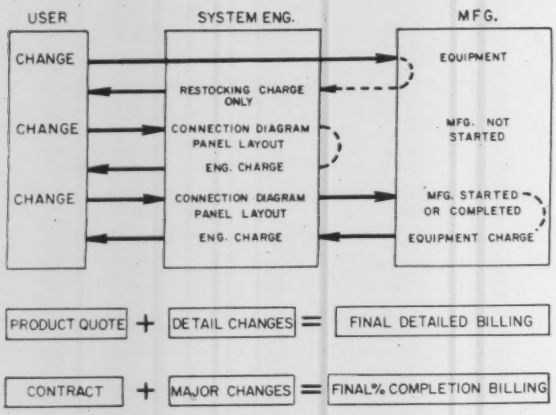


FIG. 2. CHANGES are expensive.

facturing drawings, is made. Specifically, this involves:

1. Connection diagrams must be prepared for final manufacture, and field interconnection diagrams must be submitted to the user.

2. Panel or cabinet construction drawings must be prepared for manufacturer, and final panel or cabinet mounting details, conduit layouts, and floor cutouts must be forwarded to the user.

3. Equipment not manufactured by the instrument manufacturer must be purchased and mounting and connection details forwarded to the manufacturing division. Equipment furnished by the user for panel or cabinet mounting must be identified and routed to the proper cabinet or panel. Mounting and connection details must be forwarded to the manufacturing division.

4. Manufacturing information must be prepared for all detail components in the system and forwarded to the manufacturing division. Panel or cabinet mounted items must be routed to the correct panels or cabinets.

5. Mounting details, connection details, etc. must be forwarded to the user for those transmitters, power units, valves, measuring elements, etc. which are to be field mounted.

6. Assembly, test, and operational check instructions must be prepared and final check-out supervised.

7. Special user instructions must be prepared.

If the final data and specifications are clear, this work can progress smoothly and is largely under the jurisdiction of the instrument manufacturer, but this phase becomes a nightmare if a large percentage of data is missing or if numerous changes are made.

Processing Changes in Specifications

Most systems jobs are sold before the detailed systems and equipment specifications are solidified and, as a result, it is inevitable that many changes or additions are made as the job progresses.

Changes are extremely costly because of the interlocking nature of a systems job and the custom nature of the work. In most cases what appears to be a simple change involves a number of products and departments, and an inordinate amount of paper work.

Product vs Contract Selling

A second costly effect of changes in the bookkeeping required to keep the user informed on resultant price changes. The importance of this consideration is dependent upon how the job is sold.

1. **Product Selling.** It has been characteristic of the instrument industry to sell products with all accessories listed in detail and priced separately. This method of quoting a systems job gives rise to considerable argument because the quotation, packing list, and invoice often do not agree in all particulars. It may be argued that this can be corrected easily by the instrument manufacturer, but those of you who have made efforts in this direction in your own organizations realize that to integrate the activities of the Sales, Commercial, Engineering and Manufacturing Department to use a single piece of paper for any transaction, is a formidable task. Accounting for changes under these conditions is very tedious and expensive to both the user and the instrument manufacturer and the cost of the paper work to account for the change may well exceed the value of the change.

2. **Contract Selling.** A more realistic sales procedure on large jobs is to follow the lead of heavy equipment manufacturers and to quote the complete system at a firm price. The equipment quoted would obviously have to be specified in sufficient detail to permit the customer to evaluate the bid and to protect both the user and the manufacturer against major additions or deletions from the contract. Billing in this case is done on a percent-completion basis and final billing should agree with toal price quoted as supplemented by change letters covering major changes.

Scheduling and Expediting

Scheduling a systems job is particularly difficult because it is a custom-built job for a specific user and the instrument manufacturer does not have complete control of the operation because:

(a) Specifications cannot be solidified until information can be obtained from the user.

(b) Many elements of the system cannot be started until after the user approves drawings. This may require several submissions.

(c) Changes originated by the user.

(d) Much equipment specified by the user but furnished by others must be integrated into the final arrangement.

Responsibility after Shipment

A systems job is a custom-built assembly of complex equipment to satisfy a specific objective. Therefore, it is necessary usually to train the user's personnel in the details of operation and maintenance.

In addition, supervision of the installation is usually required. This normally includes a performance of operational check before the job is accepted.

It is important to recognize that this work may proceed slowly because of erection problems or malfunction of primary equipment, which prohibits the instrument engineer from completing his part of the work. This will seriously upset scheduled start-up of other jobs, as well as estimates of man-hours.

Special instructions integrating the detailed equipment with the primary equipment and covering special operating procedures are required.

Conclusions

The foregoing remarks are intended as an analysis and definition of a systems job and of systems engineering as it applies to the instrument industry. It has been slanted toward the problems of systems engineering as a joint user-manufacturer effort to build a custom control system.

It must be remembered that this is always a joint effort between user and manufacturer, involving a sizable number of man-hours. The real problem confronting the instrument manufacturer concerns the shift in man-hours from user to manufacturer as the character of the job changes between the limits of product processing and systems job processing, and the unwillingness of many users to recognize that charges for this work are legitimate.

It appears that improvement can be made in the following areas:

1. **Evaluating the bid**—Every effort should be made by the user to evaluate instrument bids completely. To assist in this effort the manufacturer should develop industry standards relative to conditions of sale for these products. It is in the interest of both the user and manufacturer that:

(a) The contract include general provisions defining the responsibilities of each party.

(b) Specifications, or requests to bid, clearly state all essential details concerning the process to be instrumentized.

(c) The proposal of each bidder give adequate information on the equipment offered to permit comparison and an intelligent decision.

Standard conditions of sale are particularly important in contract selling and might well eliminate misunderstandings in the following areas:

Other Manufacturers Equipment. Escalation of prices, delivery responsibility, and liability after shipment for other manufacturers' equipment.

Billing Procedures. Billing procedures as job progresses (percentage billing). These and other procedures are particularly important in contract selling.

Drawings and Instructions. Number of copies of drawings and instructions to be provided. Type of drawings to be furnished—that is, reproducible tracings, blackline reproductions, etc. Coverage of drawings—that is, schematic drawings, dimension drawings, installation drawings, etc. Approval of drawings.

Limits of Responsibility. Power supplies. Valve design conditions. Power requirements for operating auxiliary devices, etc.

Scope of Work. Panel interconnection diagrams for other manufacturers' equipment. Conversion of customer control schematics into manufacturing wiring diagrams and field installation wiring diagrams. Purchasing specifications or shipping procedures for other manufacturers' equipment.

2. **The user and the manufacturer should consider the principle of contract selling and buying for large systems jobs.** This method of buying simplifies or eliminates many details in the job processing procedures.

3. **Avoid consideration of special products.** Instead, consider ways and means of using standard products at lower cost, better quality, and improved delivery.

4. **The user should recognize the engineering services provided by the instrument manufacturer on a systems job** and accept the principle of an "engineering charge" for service over and above that normally expected with an industrial product.

These remarks should not be construed to mean that instrument companies wish to limit their responsibility to their users. On the contrary, the instrument industry has been built on service and wishes to extend this service through the medium of systems jobs, which they are well qualified to process for the following reasons:

The instrument manufacturer:

(a) Can supply a large percentage of the equipment.

(b) Has fabrication facilities for panels and cabinets, and personnel qualified to do interconnecting tubing and wiring.

(c) Has the engineering capabilities to process his equipment and related competitor's equipment.

(d) Will assume complete responsibility for the entire job.

(e) Normally can supply simulation or computer assistance if necessary.

(f) Has a wide experience with many industrial processes, the application problems, responsibilities involved, and results expected.

(g) Is familiar with instrument and control performance and limitations.

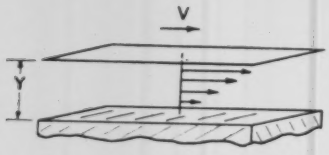
Finally, it is increasingly important that users and instrument manufacturers learn how to process systems jobs efficiently and equitably because there will likely be a higher percentage of this work in the future for the following reasons:

1. The increasing size and complexity of modern processes and the resulting pay-off from efficient operation places a premium on well integrated instrumentation and control systems.

2. In many areas of process development there is a demand to simulate new processes and their proposed instrumentation and control systems to avoid costly empirical application procedures and the possible resultant errors.

3. The instrument industry is constantly developing more complex equipment such as digital and analog computing equipment, end-point analyzing equipment, and complex supervisory control equipment—all of which must be sold, engineered, and manufactured in accordance with systems engineering procedures.

4. There is an increasing tendency on the part of users to demand that a single manufacturer accept the full responsibility for a complete installation, and also to require the instrument manufacturer to do engineering work that traditionally has been done by the user.



$$F = \eta A \frac{dV}{dY}$$

F = Force in Dynes
η = Absolute Viscosity, Poise
A = Surface Area, Sq Cm
V = Velocity, Cm/Sec
Y = Plate Separation, Cm
$\frac{dV}{dY}$ = Rate of Shear, Sec^{-1}

FIG. 1. Absolute viscosity (η) is defined as shear stress per unit area (F/A) divided by rate of shear (dV/dY). It is constant for Newtonian liquids.

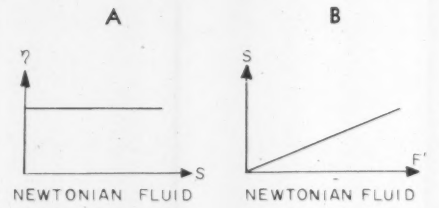


FIG. 2. Viscosity vs rate of shear for a Newtonian fluid; viscosity remains constant (A). B shows rate of shear vs force for a Newtonian fluid showing linear, proportional relationship.

Viscosity of Fluids

Many process operations can be followed best by measuring the resultant fluid viscosity. First one must know the various viscosity groups to classify any particular fluid properly.

R. A. MINARD
Brookfield Eng. Labs., Inc.

VISCOSITY is a measure of resistance to flow, and is expressed as:

$$\text{Viscosity} = \frac{\text{Shear Stress}}{\text{Rate of Shear}}$$

This formula is illustrated in Fig. 1. If a moveable plate with an area of one square centimeter is placed one centimeter away from a fixed plate of the same area, and if a fluid is contained between these plates, the force required to move the plate is proportional to the rate of shear to which the fluid is subjected. If F is the force in *dynes*, A the surface in *square centimeters*, V the velocity of the moving plate in *centimeters per second*, and Y the plate separation in *centimeters*, then η represents the absolute viscosity in *poises* in the equation:

$$F = \eta A \, dV/dY$$

A material requiring a shear stress of one dyne per square centimeter to produce a rate of shear of one inverse second has a viscosity of one poise, or 100 centipoises. It happens that water at room temperature has a viscosity of one centipoise.

Fig. 1 shows that shearing a fluid involves the motion of intermediate layers of that fluid at different velocities. The velocity gradient, or rate of shear, is expressed by the term dV/dY. Newton assumed that the force (F) would be proportional to this rate of shear—that is, that a fluid's viscosity would remain constant. Hence, when the viscosity is a constant, the material is called *Newtonian*. Such fluids include water, most hydrocarbons, mercury, and certain other commercial fluids. A plot of viscosity vs shearing rate for such a material is shown in Fig. 2.

When the rate of shear is increased and the viscosity remains the same, a shearing force/rate-of-shear curve for the same material will be linear (Fig. 2).

This rheogram shows that moving the fluid twice as fast will take twice the push—i.e., the shearing force increases in the same proportion as the rate of shear.

Non-Newtonian Fluids

Non-Newtonian materials have three main types of flow—pseudo-plastic, dilatant, and plastic.

A plastic (Fig. 3) shows a decreasing F'/S ratio after a yield value. A certain force must be applied to the material before any shear (or flow) takes place; the viscosity will approach infinity when rate of shear is low.

A *dilatant material* (Fig. 4) shows the opposite effect. The F'/S ratio increases with increasing S. The viscosity at increasing shear can reach the point where the fluid becomes solid. Hence it is important to know whether you are working with a dilatant fluid, say, before you try to increase flow by increasing pump speed—the dilatant material can solidify and break the pump.

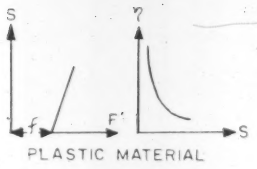


FIG. 3. Shear rate (vs force) and viscosity (vs shear rate) diagrams for a plastic. Note threshold force before flow starts.

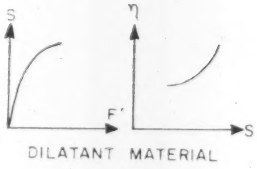


FIG. 4. A dilatant material "firms up" at increasing rates of shear.

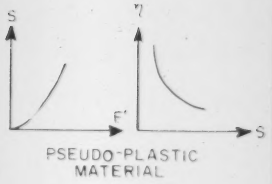


FIG. 5. A pseudo-plastic loses viscosity at increasing rate of shear.

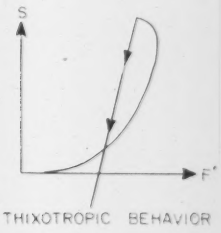


FIG. 6. Typical thixotropic rheogram; the plot will shift with time also.

With a *psuedo-plastic material* (Fig. 5), the viscosity decreases as the rate of shear increases.

Thixotropy

Another phenomena is *thixotropy* (Fig. 6), defined as a "reversible gel-sol-gel transition." This introduces an irregular time factor into the measurement of viscosity. In Fig. 6, measurements of shear stress have been made continuously while the shearing rate has been increased to a particular value and then decreased. Note that both duration of the shear and the rate at which it is applied affects the measured viscosity.

Variable vs Constant Rate of Shear

Viscometers can be divided into two principal types —those measuring *force* and those measuring *time*— these variables being related to viscosity according to the particular instrument used.

In general, those industrial viscometers in which a time measurement is made proportional to viscosity do not measure at a constant rate of shear.

Force-type viscometers measure shear force at constant shear rate. Units of force can be calibrated directly in viscosity units. This method eliminates the uncertainty that results from measuring the mean of an unknown flow curve made over unknown rates of shear.

Temperature Effects

The relationship between a fluid's viscosity and its temperature also must be considered. The viscosity of most materials will vary by approximately 10% for a change of one degree centigrade.

The Ideal Industrial Viscometer

An industrial viscometer that will perform satisfactorily under universal operating conditions and with all types of materials will meet the following requirements.

1. The instrument should perform over a wide range of process conditions, from vacuum to pressures as high as required; and over the complete range of temperatures required, say, —40°F to 2300°F.

2. It should be able to withstand extremely corrosive conditions.

3. It should have means whereby its range can be changed.

4. It should be suitable for use under explosive conditions.

5. The unit should be as free from cleaning requirements as possible. Many materials have the property of hardening, caking, and building up on the immersed portions; these portions should withstand the abuse of hard cleaning.

6. The viscometer should be able to be installed easily.

7. Accuracy, repeatability, and sensitivity should be good. (Most viscometers today have greater accuracy and repeatability than is actually needed in most applications.)

8. The viscometer should be able to work in a wide variety of materials—from simple oils and lubricants to heavy starch solutions; from catsup to cream-style corn; from nylon size to road tar; from glues to polyvinyl acetate solutions. It should be so designed that it will operate on any system as a whole—the measurement of a clay suspension, for example, should reflect the flow properties of the clay particles and water together; the measurement of cream-style corn should reflect the flow properties of both the corn kernels and the suspending medium—not the suspending medium itself.

9. A viscometer should measure viscosity and no other property. It is centipoise viscosity at any given rate of shear that determines a material's flow properties.

10. Most industrial materials are non-Newtonian. As previously shown, they should be measured at a constant rate of shear if valid results are to be insured. It should be possible to adjust this rate of shear so measurement can be made at shearing conditions approximating those the material experiences in use.

In view of the relative complexity of the viscosity variable, the theory behind an instrument's design should be studied before making a selection of instrument technique.

Automatic Viscosity Control

Viscosity is the prime variable measured and used for automatic control of many common industrial processes, including (1) solvent addition, (2) end-point determination, (3) starch conversion, and (4) blending.

AUSTIN S. NORCROSS
Norcross Corporation

A LARGE PERCENTAGE of all process control viscometer applications can be classified under one of four types—solvent control, end-point determination, starch processes, and blending.

Solvent Control

Viscometers are used widely where solvent is added automatically. Typical examples include flow coating, dipping and spraying in finishing processes; coating wire with enamel, plastic, rubber and various synthetic materials; printing, particularly rotogravure and flexographic; sizing operations in the textile and paper industries; and various coating processes for fabric, metal, paper and many other materials.

The basic system used most commonly for solvent control is illustrated in Fig. 1. The measuring element (A) can be installed in the process tank, in a sampling tank added to the system for measuring purposes, or in a side stream of a pipeline in the system. The measured viscosity usually is transmitted electrically to the controller, shown as a recorder-controller in Fig. 1. A solvent valve and throttling valve are installed in the solvent feed line. When evaporation causes the viscosity to exceed the control-point setting, the solvent valve opens. The throttling valve is preset for load conditions and prevents over-correcting. Changes in viscosity are slow because the volume is large compared to exposed evaporating surface; thus on-off control is satisfactory as corrections are made before viscosity increases appreciably above set-point value.

Explosion-proof equipment generally is required for the measuring element and solvent valve. The controller can be located out of the hazardous area, or purged with an inert gas when used within such an area. High and low alarms can signal if the control is unable to maintain the viscosity within preset limits. *Agitation is necessary to provide mixing.*

Solvent control processes are either at ambient conditions or at a controlled temperature; if controlled, the temperature variation should be small. Temperature changes under ambient conditions can be appreciable but are gradual so that the controller can maintain a constant viscosity. For most applications of this type, such variations in temperature are not objectionable—provided the viscosity is maintained constant.

Where several solvent control applications are in the same area, one recorder-controller can be used with several measuring elements, resulting in a substantial saving in equipment costs. Multiple systems of this type are particularly suitable for rotogravure and flexographic printing processes.

End-Point Determination

Viscometers are used commonly to record viscosity automatically during polymerization and other chemical reaction processes. The viscosity record shows all changes as they occur so that the process can be terminated at the correct viscosity. A high-viscosity alarm can indicate the approach of the end point. The process can be terminated automatically, but such a refinement is usually pointless because operating personnel always follow the batch closely at this time.

Typical examples are bodying of linseed, tall and other oils; polymerization of resins such as alkyd, epoxy, phenolic, polyester, polyurethane, polystyrene, silicones, turpene vinyl; manufacture of viscose, acetate and nylon; and polymerization of polyvinyl acetate emulsions.

The operating conditions for a measuring element applied directly to reactors are often severe. Reproducible measurements are required under operating pressures from full vacuum to above 300 psig, and temperatures of 600°F or higher. Explosion-proof design is normally required, and provision must be made for purging, flushing and dissassembling for cleaning.

Most reactor processes require accurate temperature control of the liquid so that the viscosity measurements are meaningful.

Starch Processes

For over a decade, viscometers have been used in the preparation and quality control of starch solutions for sizing and coating processes in the textile and paper industry.

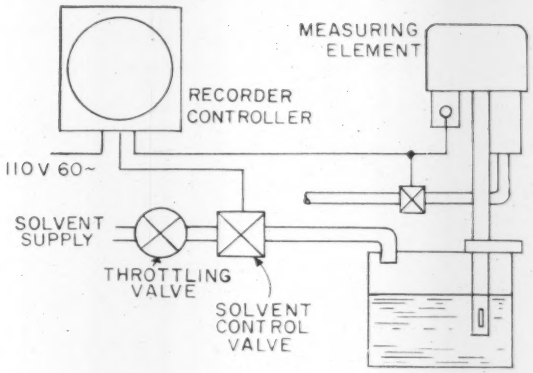


FIG. 1. VISCOSITY CONTROL circuit for addition of solvent.

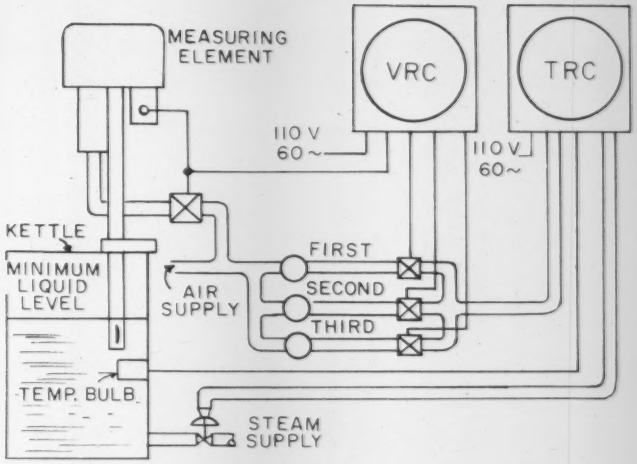


FIG. 2. TIME-TEMPERATURE programmed starch conversion with viscosity detection of end point.

Fig. 2 shows an enzyme starch conversion system which accurately finishes each batch to the desired viscosity. The ingredients specified in the formula are added to the kettle and the start button depressed. The three-stage process then is controlled automatically.

First Stage: Preconversion. The temperature is raised to approximately 150°F, where it is maintained for a predetermined length of time.

Second Stage: Conversion. The temperature is raised to about 170°F and controlled accurately until the conversion is completed to a predetermined viscosity regardless of variations in chemical and moisture content of the ingredients used in the formula, amount of condensation from steam, and other factors that affect the actual converting time. By converting accurately to the correct viscosity each batch is more uniform than can possibly be obtained by using the time-cycle controllers.

Third Stage: Inactivation: When conversion is complete, the temperature is raised to approximately 205°F as quickly as possible and maintained at that value for sufficient time to inactivate the enzyme.

The viscosity determined by the measuring element in Fig. 2 is transmitted electrically to the recorder-controller. The viscometer recorder-controller incorporates a viscosity control-point setting for the conversion stage, and timer for the preconversion and inactivation stages. It also positions the temperature controller set point as required for the various stages.

The temperature controller usually has proportional plus reset mode of control.

Blending

There are many pipeline applications in the petroleum and chemical industries where liquids are blended continuously to make a product to specifications. The viscosity of the blended product can be measured with a viscometer installed either in a side stream or directly in the main line. The necessary sample flow can be maintained in the side stream either by a restriction in the pipeline or by adding a small pump in the sample stream. In some instances the side stream can be connected across an existing pump in the main line to obtain the sample flow. Viscosity measurements also can be made by bleeding off a small sample continuously for measuring at atmospheric pressures. For most applications of this type the effect of temperature variations must be taken into consideration.

Temperature Corrections

Corrections can be made for temperature by (1) controlling the sample temperature accurately to a predetermined value, (2) temperature compensation, or (3) a combination of the two. Combined control holds temperature within rough limits with temperature compensation applied within these limits.

Accuracy in the order of 1% usually is required; to obtain this with temperature control alone the temperature must be maintained within ±0.2°F for most products. This is closer control than can be obtained with most industrial temperature controllers in field installations of this type. There has been considerable interest in straight temperature compensation, but for wide temperature variations the obtainable accuracy usually leaves much to be desired. Consequently the combination of temperature control and temperature compensation is used often. The temperature can be maintained within ±5°F or ±10°F and within this range the viscosity index adjustment is simplified. However, the cost for the combination method is relatively high because of the many components required, and the viscosity index adjustment is an undesirable feature.

Recent developments in temperature-control equipment suitable for field use and capable of maintaining close control now make temperature control alone feasible for many applications. At the present time the trend is in this direction.

THOMAS A.

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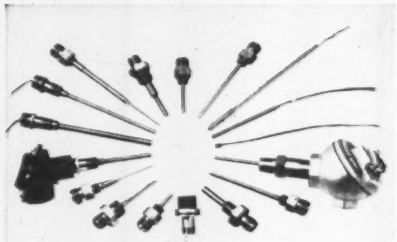
- **High-stability eliminates periodic calibration.** Because resistance wire is made from high-purity nickel and platinum. These metals are not subject to the contaminating effects of adverse atmospheres. As a result, there is no need for periodic recalibration.
- **Accurate.** As evidence of the unmatched accuracy of the Resistance Temperature Detector, the U. S. Bureau of Standards uses a platinum wire detector for measuring temperatures between minus 300°F and plus 1165°F. Standard Edison detectors are available with accuracy of 0.5%.
- **Rugged.** Edison detectors are designed to withstand the abuse, shock and vibration of industrial applications where other detectors can not survive. Typical of the tough jobs being handled by Edison detectors are sensing applications on the bearings of ore crushers, heavy conveyors, pulverizers and both turbo-jet and reciprocating engine aircraft.
- **For additional information** write for bulletin RTD #3047.



Edison Detectors are available for a wide range of applications and almost any type of service. They are compact, corrosion and vibration resistant.

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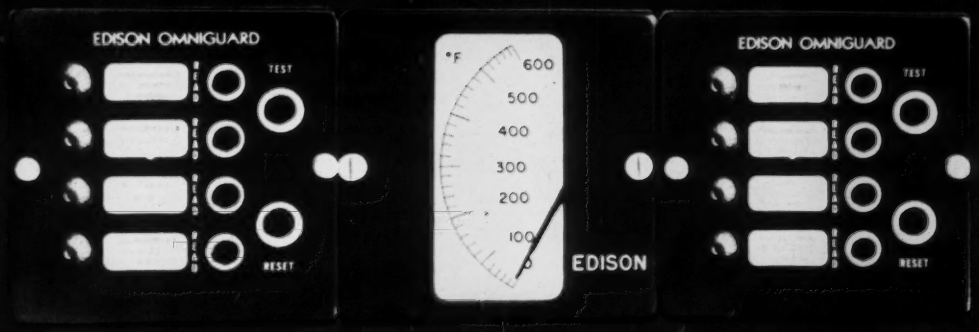
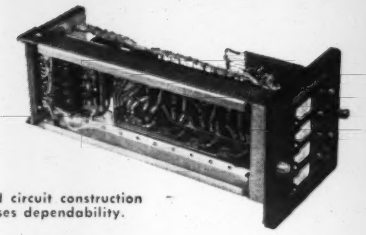
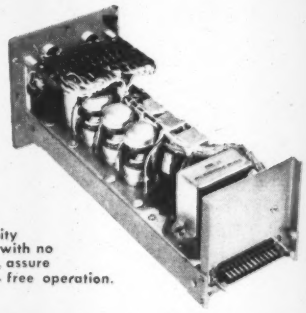
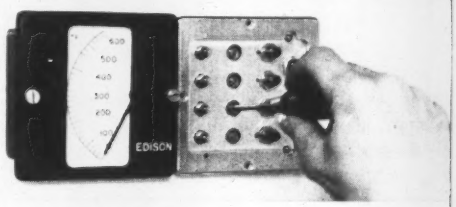




Printed circuit construction increases dependability.



Highest quality components, with no moving parts, assure maintenance- free operation.



Easy access to all components permits quick temperature settings and monitoring system changes - at any time.

Model 310 Edison Omniguard with Model 311 Indicator — a single indicator can read any number of temperature points.

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new model 310 omniguard temperature monitor... unmatched for versatility

The new Model 310 Edison Omniguard provides the simplest, most dependable temperature detection system yet devised... for both small and large installations.

The Omniguard system is reliable... flexible... economical. You order only the plug-in units needed, add new units as your monitoring needs expand.

Check these features of the new Edison Omniguard:

1. **VERSATILE:** One instrument can be used for both normally open and normally closed annunciator... for alarm or for shutdown of equipment.

2. **FLEXIBLE:** Quick, inexpensive system changes and additions . . . easy tie-in with any type annunciators or cut-off switches.

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4. **SIMPLE:** Single indicator reads any number of temperatures, needs no periodic adjustment. With a minute's briefing, *anyone* can operate the simple Omniguard monitoring system.

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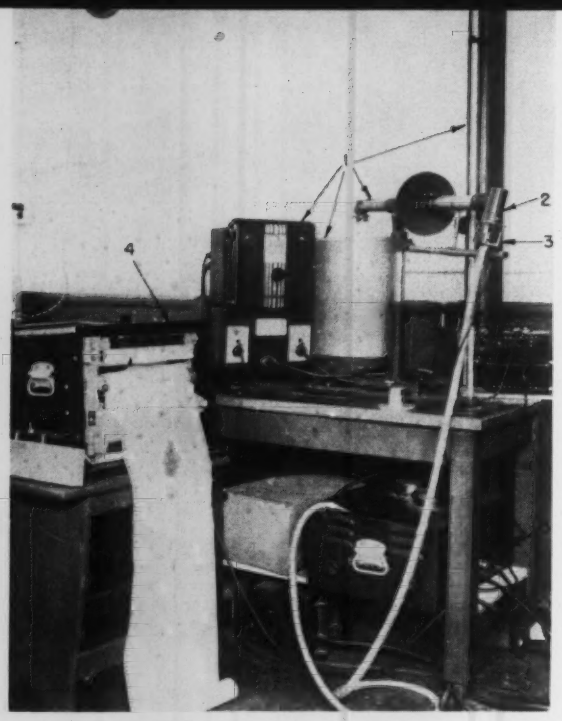


FIG. 1. The equipment.

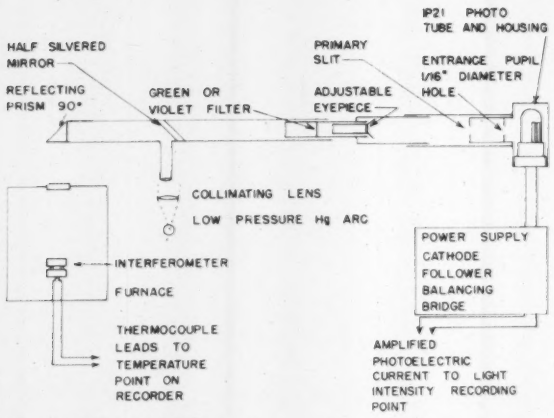


FIG. 2. SCHEMATIC vertical section of the equipment.

RECORDING

Thermal expansion measurements of materials can be made accurately and rapidly by an interferometric dilatometer plus photoelectric recording attachments.

A COMMERCIALLY available interferometric dilatometer (Gaertner manufactured, Bureau of Standards developed) has been converted into a recording instrument by the addition of a 1P21 photomultiplier tube with its associated circuitry, housing and optical pick-up system (Fig. 1). The data are recorded with a commercial two-point strip-chart recorder. One point records the temperature of the specimen as measured by a thermocouple in contact with the lower plate of the interferometer. The other point records the intensity of the light entering the pupil (an adjustable slit or a 1/16″-diameter aperture) of the photomultiplier receiver housing. The fringe pattern, which is focused in the plane of the entrance pupil, records as a $\cos^2 x$ curve on traversal of this opening. Thus it is possible to measure fringe shifts accurately to one quarter wavelength. Measurements of thermal expansion have been made on several materials and the results are in agreement with accepted literature values.

The Dilatometer

The interferometric dilatometer[1, 2] is employed for studies of thermal coefficient of expansion and phase changes in solids. It consists of two quartz interferometer plates, generally about 1″ to 1-½″ in diameter, between which the samples to be measured are placed (Fig. 2). Three specimens are usually used and these act as separators between the upper and lower interferometer plates. Parallel, monochromatic light rays falling upon this assembly are partially reflected from the lower surface of the upper plate and from the upper surface of the lower plate.* The difference in optical path of the two reflected beams causes interference fringes to appear at the entrance pupil to the photomultiplier. Dark interference fringes result when the path difference of the two reflected rays equals ½ the wavelength of the monochromatic light.

When the assembly is heated by a controlled-temperature electric furnace, the length of the specimens changes, causing a shift in the fringes. Counting the fringes result in an exact determination of the expansion of the specimens.

For small specimens of material the instrument is ideal. The non-recording visual instrument, however, has the disadvantage that visual fringe counting requires continuous and undivided attention over periods of many hours. The tedium of operation may account for the fact that its use has been limited.

1. Merrit, G. E., *J. Research NBS*, 1 Vol. 10, p. 59, 1933, RP 515
2. Saunders, J. B., *J. Research NBS*, Vol. 23, p. 179, 1939, RP 1227

*The interferometer plates are so designed that reflections from the top surface of the upper plate are deflected out of the optical path and those from the bottom surface of the lower plate are scattered so that they contribute nothing to the interference

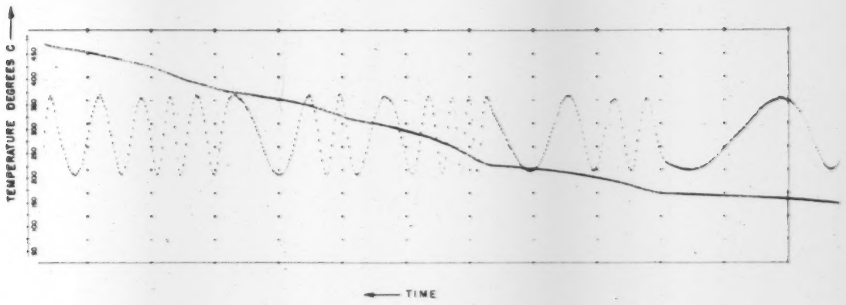


FIG. 3. RECORD of expansion of aluminum discs.

INTERFEROMETRIC DILATOMETER

MILTON GREEN, S. BENEDICT LEVIN and IRVING N. GREENBERG

U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

Various photographic methods [3, 4] of recording the fringe shifts have been developed to eliminate this objection. Photoelectric detection with electronic recording of fringe motion and specimen temperature shows certain advantages over photographic methods, including the elimination of film processing and the presentation of data on a strip chart in a form convenient for immediate use. The thermal coefficients of expansion can be determined from the chart with less processing than by other interferometric methods. The course of measurement can be followed and adjustments made whenever necessary. The rate of recording is limited only by the permissible rate of heating of the sample without introducing error.

Previous work on photoelectric recording of thermal dilation of materials by the fringe motion has been reported by R. N. Work[5], and Vernon and Weintroub[6]. In many respects their methods and the one described here are similar, but there are some significant differences both from the standpoint of instrumentation and in method of operation.

3. Saunders, J. B., *J. Research NBS*, Vol. 35, p. 157, 1945, RP 1668
4. Nix and Mac Nair, *Rev. of Sci. Instr.*, Vol. 12, p. 66, 1941.
5. Work, R. N., *J. Research NBS*, Vol. 47, p. 80, 1951, RP 2230.
6. Vernon and Weintroub, *Proc. Phys. Soc.* (London), Vol. B66, p. 887, 1953.

The Instrument

The instrument (Fig. 1) consists of (1) a conventional interferometric dilatometer, manufactured by Gaertner Scientific Co., with light source; (2) photoelectric attachments; (3) a power supply and a cathode follower circuit for the photo-tube output; and (4) a two point commercial electronic strip-chart recorder with both points calibrated to measure temperature from 0 to 500°C for a chromel-alumel thermocouple.

The Record

On the chart one point records temperature in degree centigrade, and the other point records the variation in light intensity of the fringe pattern as it traverses the entrance pupil to the photoelectric tube. Both these variables are recorded as a function of time and it is an easy matter to plot the recorded data into a graph of expansion versus temperature. Examples of the record are shown in Fig. 3.

The Photoelectric Receiver and Associated Circuitry

The 1P21 Photomultiplier tube (Fig. 4) is housed in a light-tight brass cylindrical tube which fits over a cylindrical telescopic adjustment that is screwed onto

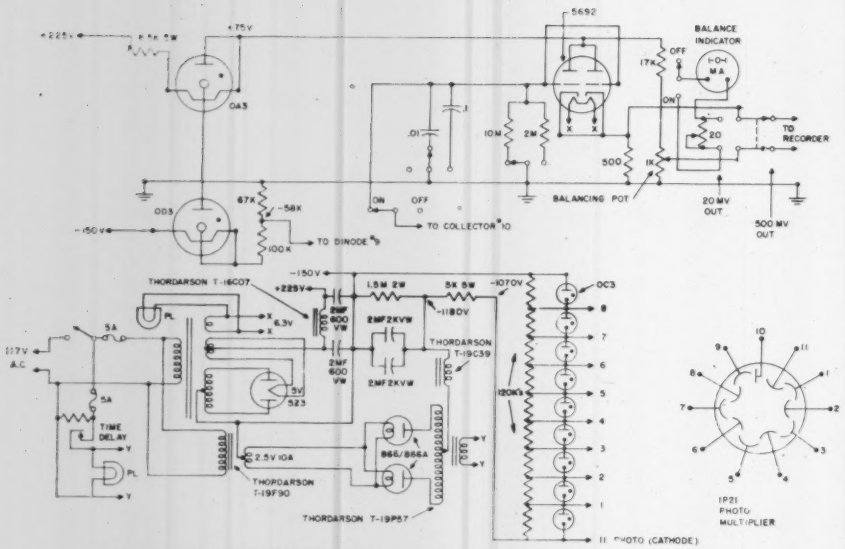


FIG. 4. PHOTOELECTRIC circuit and power supply.

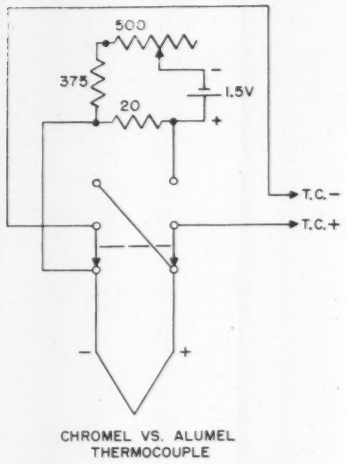


FIG. 5. CIRCUIT for increasing temperature range from 500°C to 1000°C without reducing scale unit.

the eyepiece tube of the instrument. An image of the fringe pattern is brought to a focus, by the eyepiece, onto a disc in front of the sensitive surface of the phototube. A hole approximately 1/16″ in diameter (or an adjustable slit) in the disc serves as an entrance pupil to limit the area of the fringe pattern falling onto the photocathode.

The circuit consists of a power supply, with output voltages of approximately 375 and 1000 volts, and a cathode-follower amplifier. The amplifier is essentially a 5692 (a 6SN7-GT can be used) electron tube in which both triodes are operating in parallel. The triodes are operated by means of a 75-volt plate supply stabilized with an OA3 glow tube. The signal input to the amplifier is generated by passing the output current of the 1P21 through either a 10- or a 2-megohm grid resistor, depending on the sensitivity desired.

Electrical filtering of the input signal to the amplifier is available through the use of the 0.01- and 0.1-microfarad capacitors, either of which can be switched into parallel with the grid resistor. For optimum design (threshold signal performance), the amplifier tube and associated input circuit should be housed in a compartment adjacent to that of the photomultiplier tube.

The output of the amplifier is designed to work into either a 500-mv or 20-mv low-impedance recorder. The output circuit is also provided with electrical means for centering the signal on the recorder chart. After one-hour warmup time the instrument is stable and exhibits little drift.

Light Source and Monochromaticity

The light source is a low-pressure mercury-arc lamp which comes as an integral part of this dilatometer. Interchangeable green and violet glass filters located in front of the eyepiece serve to pass only the green mercury arc line 5461A°, or the violet mercury arc line 4358A° respectively. The lines are sufficiently sharp and the filter pass band sufficiently narrow to produce good interference patterns for path differences of ¼″. No attempt has been made to obtain patterns for path differences of greater than ¼″. It is estimated, however, that patterns of sufficient contrast for measurement can be obtained with path differences up to about ½″.

Recording of Temperature

The temperature is measured with a chromel-alumel thermocouple placed in contact with the bottom surface of the lower interferometer plate (Fig. 2).

The two point recorder used in this work is factory-calibrated to record the temperature of the hot junction of a chromel-alumel couple from 0° to 500°C. The circuit shown in Fig. 5 extends the range of the recorder to 1000°C and still maintains the expanded scale; it is inserted between the sensing thermocouple and the emf input terminals of the recorder. In this circuit the voltages are adjusted so that the direction of increasing temperature above 500°C is down-scale and for temperatures below 500°C it is up-scale. This avoids a break in the temperature curve while at the same time it expands the scale by a factor of 2 over a single-scale traversal.

As shown in Fig. 5 the dpdt switch is in position for the measurement of temperatures below 500°C; switching to the other position permits measurement of temperatures above 500°C. The switch can be manually or relay operated.

The reference junction of the thermocouple was held at room temperature since the recorder is internally compensated for changes in ambient. The circuit in Fig. 5 will be compensated (for temperature recording with chromel-alumel couple) against changes in the ambient provided the 375-ohm resistor is wound of copper and the other two of manganin. The 500-ohm potentiometer of this circuit is adjusted so that the emf at the recorder terminals, for both positions of the switch, correspond at 500°C. When properly adjusted the circuit draws approximately 2 ma from the 1.5-volt battery.

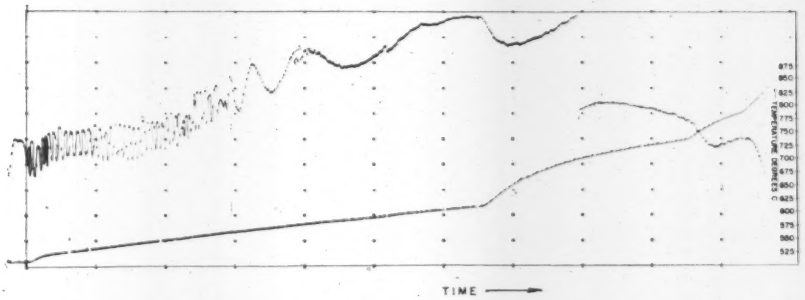


FIG. 6. **RECORD** of expansion of quartz.

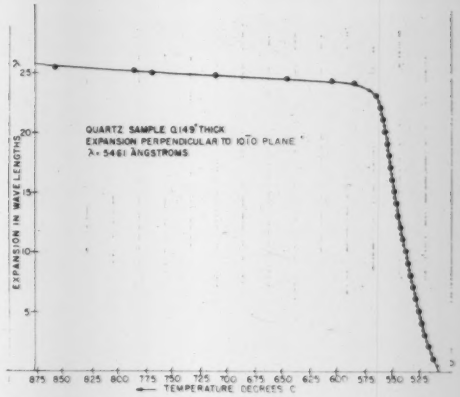


FIG. 7. **TEMPERATURE** expansion curve of quartz.

Results

Preliminary experiments indicated that fringe-pattern recording could be improved significantly through the controlled coating of the interferometer plates to appropriate reflectance values. As can be predicted from simple calculations, the first two interfering rays can be made to have about equal amplitudes by silvering the upper plate to transmit approximately 62% of the incident radiation and the lower to reflect approximately 95%.

Although the use of interferometer plates coated with silver appeared to give greater contrast (signal-to-background ratio), the coating would not stand up under elevated temperatures. The film seemed to disintegrate at temperatures around 200°C, probably due to oxidation. In order to overcome the temperature limitations of the coated interferometer and to establish the usefulness of the uncoated plates, the instrument was set up to operate with uncoated plates. An example of the performance of the interferometric dilatometer in recording the expansion of aluminum from room temperature to near 500°C, with uncoated interfermeter plates and slit entrance pupil, is shown in Fig. 3. The samples were in the form of discs, 0.025" thick by 5/16" diameter, of which three were used as the interferometer spacers. The record reads from right to left. The monotonic curve is the record of specimen temperature as a function of time (chart speed 8 inches per hour). The wavy curve is the record of light intensity at a fixed "point" of the interferometer, plotted against the same time scale—that is, it is a record of the fringes traversing the photocell aperture. The expansion curve for aluminum in terms of wavelengths of light is easily derived from Fig. 3. The average coefficient indicated over the range 25° to 460°C is 2.3×10^{-5} parts per unit length per degree centigrade.

Heating rate in this experiment was variable due to manual control. The variation in rate of temperature change is responsible in turn for the frequency modulation of the fringe patterns. Experiments with this equipment showed no evidence of lag between the temperature of the specimen as measured with the thermocouple, and the fringe record up to heating rates of 10°C per minute.

The Expansion and Phase Transition from α to β Quartz

A record of the expansion of quartz, perpendicular to $(10\bar{1}0)$ plane, is shown in Fig. 6. Of particular interest is the α and β phase transition, occurring in the vicinity of 570°C. In the region of constant rate of increase of temperature (long straight portion of temperature curve) it is observed that, at first, the "waves" due to the light intensity variation are closely spaced, and after they pass through a certain point corresponding to the transition temperature they begin to spread out indicating a change in the coefficient of expansion. It is also apparent that just before this transition point is reached there is an interval in which the amplitude of the fringe traces is considerably reduced. It is in this interval that the transition takes place. The expansion in volume associated with the transition is occurring too rapidly for the recorder to follow; hence the small amplitude.

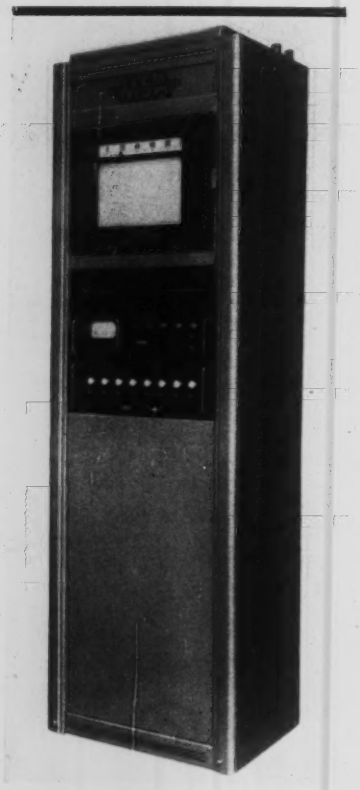
The break in the light intensity curve near the end of the record is a result of translating the curve downward (by applying a voltage bias) so as to prevent it from running off the chart. The decline in the curve that follows thereafter is caused by the incandescence in the furnace as a result of high temperature. The record was taken with the green filter. When the violet filter is used, the effect of the incandescence is suppressed to somewhat higher temperatures.

Repeat measurements of the expansion of the quartz through the α to β transition have been made using the violet filter, both on heating and cooling. In each case the records on the chart show the same behavior as shown in Fig. 6, indicating that the instrument performance is quite reproducible.

A temperature expansion curve for quartz derived from the record of Fig. 6 is shown in Fig. 7. The volume change accompanying the phase transition is not shown. The recorder was not fast enough to follow it for the conditions of the experiment.

Acknowledgment

The assistance of Mr. Jack Treynor in operating the equipment for dilation measurements, and the services of Mr. Carey Shearer in assisting in constructing the equipment, are gratefully acknowledged.



Combustible-Gas Analyzers for High-Temperature Operation

Combustible-gas analyzers that can operate at 350°F bring greater safety to solvent drying ovens.

NELSON W. HARTZ
Mine Safety Appliances, Co.

FIG. 1. COMBUSTIBLE gas analyzer rack. Recorder plots percent "explosibility."

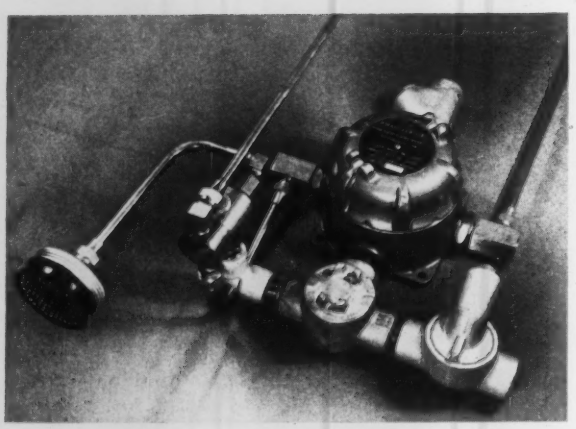


FIG. 2. THE REMOTE HEAD is explosion-proof for installation in hazardous areas. It comprises a special detector cell and a high-temperature air-purge solenoid valve. Analysis is made without condensation of vapors as the remote head makes its measurement in the hazardous area at process temperatures and transmits the electrical signal to an indicating or recording instrument.

SINCE their introduction some thirty years ago, efforts have been made to adapt combustible-gas analyzers (Fig. 1) to continuous monitoring of the concentration of flammable vapors in ovens drying coated fabrics, abrasive products, brake linings, cast plastic films, etc.

Usually such indicators or recorders are graduated from 0 to 100% of the *lower explosive limit* (L.E.L.) of the solvent being evaporated, or in a narrower range, such as 0 to 50% L. E. L. These monitors can be equipped either to operate warning signals or to actuate automatic emergency shutdown equipment if the vapor content of the air in the oven exceeds some pre-established percentage of the lower explosive limit.

Operation

Combustible-gas analyzers draw a sample of the atmosphere to be analyzed over a heated platinum filament. Combustibles present in the samples are burned upon contact with the wire, thus raising its temperature and increasing its electrical resistance in proportion to the concentration of combustibles in the samples. This wire filament is one arm of a Wheatstone bridge. An indicating meter, a contact-making meter, or recorder in the circuit indicates gas concentration. A motor-driven pump circulates the sample, and a flowmeter shows whether the prescribed rate of sample flow is being maintained.

Until recently such instruments have been limited to applications where the solvent boiling point has been under 140°F. Higher temperatures weakened

the plastic insulators used in the sensing elements of the analyzers.

Vapors of solvents having higher boiling points could be withdrawn from an oven through metallic sample lines but they were liable to condense. This caused low readings and possible plugging of the sampling system. If the filament chambers were inserted into the oven there was danger that the heat would distort the filaments, which also caused erroneous readings and risked rupture if there was an explosion within the detector housing. An instrument that was intended for safety would then be responsible for igniting the oven vapors, causing the whole oven to explode.

New Components and Circuitry

Improved equipment (Fig. 2) now eliminates this hazard by using ceramic parts in place of plastic elements. The new filament is larger than that in earlier models and can be expected to give more than a year of continuous trouble-free service before replacement.

Another advancement was made by providing compensation for variations of temperature and moisture content of the sampled atmosphere. Temperatures vary widely and, in some ovens, cyclically. Also, humidity of the air in the oven is sometimes increased periodically by steam jets. Compensation is achieved by adding a second platinum filament (identical to the detector filament), which is connected as a second arm of the bridge circuit. A minute volume of the sampled atmosphere is drawn over the second filament after the first. In this way both filaments are surrounded by the same atmosphere, with the volume of vapors available for burning on the detector considerably greater than that entering the compensator filament chamber, thus producing a substantial temperature difference for the two wires, which gives a compensated signal.

Fail-safe features include warning signals in the event that a filament burns out or that the sample flow varies more than ±25% of normal; the allowed variation has no significant effect on the instrument's accuracy.

Standards published by the National Board of Fire Underwriters for Class A Ovens and Furnaces, as recommended by the National Fire Protection Association, have prescribed the use of combustible gas analyzers for all such structures for many years. The limitations of the available instrumentation meant that oven designers and builders had no alternative but to omit this safeguard from many such structures. Analyzers designed specifically for high-temperature operation fill this void and are making an important contribution to the safety of solvent drying ovens.

SLICING SHOCK-SENSITIVE MATERIALS

HEART of the transistor is a carefully machined wafer of germanium or silicon, brittle and shock-sensitive materials. The wafers are cut into thin slices from bars or ingots of the metal (Fig. 1). Then the wafers are lapped to a fine finish and diced into small rectangles or squares of the desired size. So critical are these materials that a shift of a few revolutions per minute in cutter speed or a hardly detectable change in stock feed rate can shatter the crystal or crack it. Also, there must be no vibration. These same problems are encountered in processing quartz, ceramics, barium titanate, hardened metals and granites.

Diamond Wheel Saws

Thin diamond wheels are used widely for cutting these critical materials. They are hard enough to withstand considerable abrasion and thin enough to prevent unnecessary waste of material.

Slicing Machine

The 'Microto-matic' precision slicing machine (Fig. 2) provides positive table motion at speeds as low as 1/16″ per minute through the use of standard hydraulic valving. Automatic hydraulic control provides positive crossfeed index to ±0.005″, giving accurate wafer production to the same dimension.

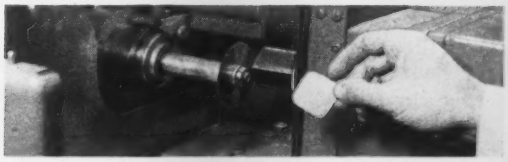


FIG. 1. ROTATING WORK-HOLDING fixture enables a small diameter cutter to sever the work. The 3" diameter cutter shown is only 0.015" thick, and is used to cut ingots 1¼" across. (Photo courtesy DoAll Co.)

FIG. 2. MULTIPLE CUTTERS dice germanium and silicon wafers cemented to ceramic plates to assure maximum rigidity. Table speed is 1½" to 2" per minute. (Photo courtesy DoAll Co.)

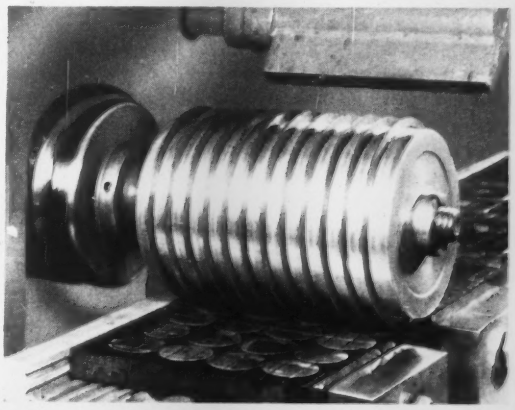


FIG. 1. Mascot—mass spectrum digitizer which converts the amplitude and true mass number of each mass-spectrum peak (except metastable peaks) into a signal to a parallel-entry-type paper-tape printer.

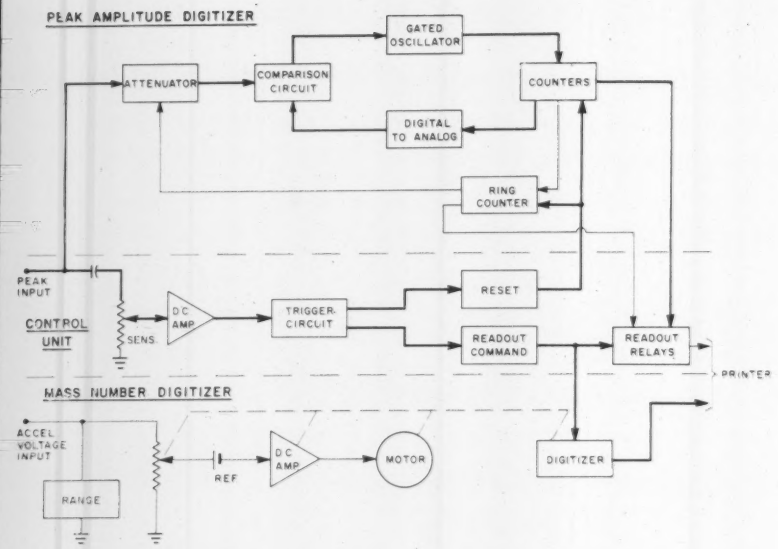


FIG. 2. Simplified block diagram of Mascot system.

Mass Spectrum Printout

Measuring and tabulating peak heights from mass spectrometer oscillograms is time consuming This time can be cut substantially with a new, all-electronic digitizer that should widen the use of mass spectrometry.

ROYCE HOWARD
Consolidated Electrodynamics Corp.

IN HIGH-MASS SPECTROMETRY, especially, the budget-breaking manpower load required for "record picking" has seriously hampered this analytical technique. The Spectro-SADIC* digitizes preselected or programmed peaks and is useful in routine control analyses where the peaks to be used in computation are known in advance.

The Mascot* (Fig. 1) is a completely unprogrammed digitizer designed to provide tabulated digital conversion of the analog output from a mass spectrometer. It converts the amplitude and true mass number of each mass-spectrum peak (except metastable peaks) into a signal to a parallel-entry-type paper-tape printer. Readout is available continuously during the mass spectrometer's run for on-the-spot analysis or for dispatching to a computer.

The analog-to-digital converter must convert analog signals from the mass spectrometer into decimally digitized form, reject spurious information, operate fast, and have capacity, precision and reliability.

Ion Acceleration Voltage

The mass-number digitizer is a digital voltmeter which tracks the ion accelerating voltage continuously during a scan. It consists of a computing servo system (Fig. 2, bottom) which converts the accelerating voltage into a shaft position of the ten-turn precision potentiometer. A shaft-position digitizer attached to the potentiometer shaft converts the instantaneous shaft position into four decimal digits. After the crest of each peak the digitizer is read out into the printer.

*Consolidated Electrodynamics Corp.

True mass number is read out because of the linear relationship between mass number, accelerating voltage, and shaft position. Four overlapping mass ranges are provided, ranging from 12.0 to 120.0, 25.0 to 250.0, 50.0 to 500.0, and 90.0 to 950.0. In the lower three ranges accuracy is ± 0.2 of a mass number. In the highest range it is ± 0.5. These accuracy figures represent the maximum excursion from the true value which can occur at constant magnetic field. Adequate precision in mass number "tracking" is assured by a span calibration system. Either whole or fractional mass peaks will be recorded, with correct mass measurement.

Control Signal

The incoming peak amplitude signal from the mass spectrometer's ion current amplifier follows two paths. The signal is differentiated within the control unit by the condenser-potentiometer combination (Fig. 2, center) and amplified to actuate the trigger circuit.

At the onset of a peak the positive-going differentiated peak signal turns the trigger on to reset the amplitude counters and ring counter to zero. At the crest of the peak the negative-going differentiated peak signal turns the trigger off to initiate the readout sequence. Thus, the control unit contains a "peak recognition" circuit which controls the operation of the Mascot. The use of a differentiator circuit, which responds only to sharply rising peak signals, helps to eliminate noise and metastable smears from the printed data.

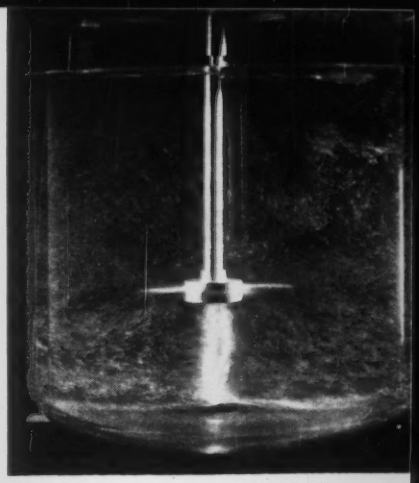
The other path followed by the incoming peak amplitude signal from the mass spectrometer is into the peak digitizer chassis (Fig. 2, top). The signal goes first through the attenuator, which is initially on X1, to the comparison circuit. If the absolute value of the peak signal is larger than a feedback voltage, the gated oscillator will be turned on to generate 25-kc pulses. A set of counters starts counting the pulses the instant the gate is opened.

These counts, in the form of a binary-coded decimal, are subsequently converted by buffers and relays to decimal-coded contact closures for a readout device. Simultaneously, the counts are converted back to a proportional analog signal in a digital-to-analog converter. This signal is fed back to the comparison circuit where it opposes the incoming, attenuated mass-spectrometer signal. If less in magnitude, it permits the opening of the gate; if equal to or greater, the gate remains closed. Thus, the counters will continue to count the 25-kc pulses until the feedback voltage, which is proportional to the instantaneous count, is exactly equal in magnitude to the incoming peak signal.

As soon as the hundreds counter reaches full scale a ring counter is advanced. The ring counter inserts precision resistors into the input through high-speed relays and at the same time presets the counters. Additional relays provide print-out of the attenuation factor.

The speed of 2½ peaks per second requires readout by a parallel-entry printer (either Clary or Victor). Either whole or fractional mass peaks will be recorded, with correct mass measurement.

C. J. PENTHER
Shell Development Co.



JET-STIR IMPELLER

GOOD STIRRING is essential in liquid constant-temperature baths to reduce temperature gradients. It also is required to lower the dead time between heater and detector.

By combining centrifugal pump action with a pitched-blade propeller, the Jet-Stir Impeller* has increased stirring efficiency. The full horsepower of any stirring motor can be converted to random motion of the bath liquid with blades no longer than the propellers ordinarily used. Both the lift of the blades and the pump is upward, which lessens the tendency to form a vortex and draw air into the bath fluid.

Fig. 1 is a photograph taken an instant after the stirrer was started. Aluminum paint flakes were allowed to settle in kerosene and the photograph shows them as most had been lifted from the bottom and dispersed in the container. The flow pattern illustrates the thoroughness of mixing. A moment later the concentrations of flakes being lifted to the inlet of the pump also was dispersed.

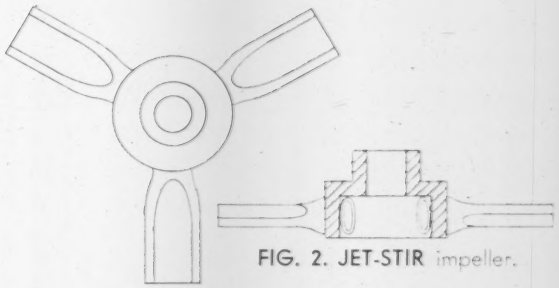


FIG. 2. JET-STIR impeller.

Construction of the impeller is shown in Fig. 2. Several of these were made with blade radii varying from 1-1/16″ to 3-3/16″. The horsepower required at 1725-1750 rpm in water for each blade varies approximately as the fifth power of the radius ($hp = 6 \times 10^{-3} \times R^5$) where R = radius of impeller in inches.

When equipped with a hollow shaft, the impeller can introduce and mix one liquid or gas with another.

*Penther, C. J., U. S. Patent No. 2,816, 744 December 17, 1957; available from Hallikainen Instruments.

Mapping System Uses Digital Printer

PAUL KINTNER

Airborne Instruments Laboratory
Division of Cutler-Hammer, Inc.

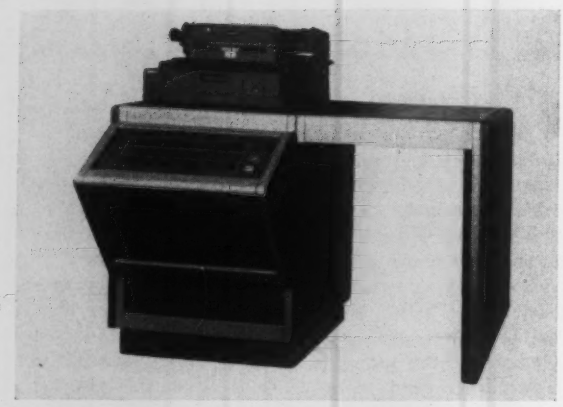


FIG. 1. DIGITAL READOUT and printout system for stereomapper.

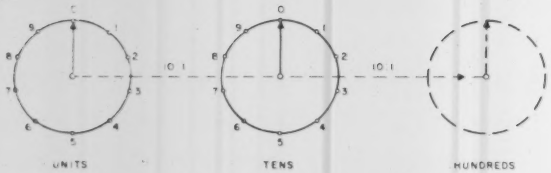


FIG. 2. DECADE COMMUTATORS digitize shaft positions.

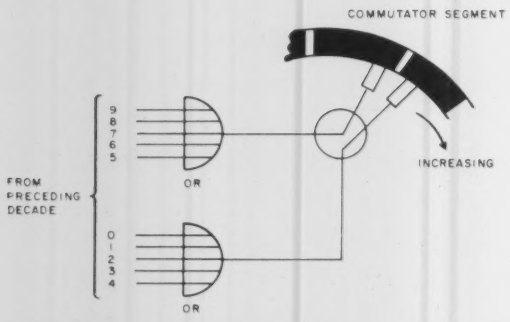


FIG. 3. DUAL-BRUSH SYSTEM of resolving ambiguity.

A STEREOMAPPER determines the coordinates of points along the earth's surface based on an aerial photograph. The vertical coordinate is determined by stereo technique.

Assume that a 100′ hill were to be photographed from a 5000′ altitude and positions 1000′ apart. If these two photographs are supplied separately to the eyes, the hill would appear like a 2.5″ anthill viewed from 12.5″; the hill stands up in bold relief.

The stereomapper gives a method of very accurately using this stereo effect to measure elevation. A "floating dot" is developed optically and moved by the operator until it appears to him to coincide with the photographed surface. Measurements of elevation can be made by this method with an error of less than 0.01 foot. The output of the mapper is the angular positions of three lead screws that correspond to the x, y, and z coordinate values of the point.

A system developed by Airborne Instruments Laboratory for the civil engineering consulting firm of Lockwood, Kessler, and Bartlett of Syosset, N. Y., has the following specifications:

1. The mapping machine from which data will be taken is the Wild A-5 photogrammetric device. Accommodation will be made for sixteen decimal digits of data.
2. Data will be prepared for entry into a Bendix G-15 computer.
3. A visual digital display of the output values will be given.
4. A printed record of the output, in addition to the computer input record, will be made.
5. The output of the mapping machine will be "stored" to permit the recording of the data coincidentally with measurement of the next point in the process.

The digital readout system (Fig. 1) consists of (1) a method of converting the lead-screw angular positions into digital values, (2) a storage register and gate for placing the digital values into the register, (3) a programmer for sequencing the stored digital values, one character at a time, into the typewriter and punch, and (4) an electric typewriter and paper tape punch for recording data.

Shaft Digitizing

The shaft digitizer (made by Jones & Wetlaufer) converts lead-screw angular position into digital values

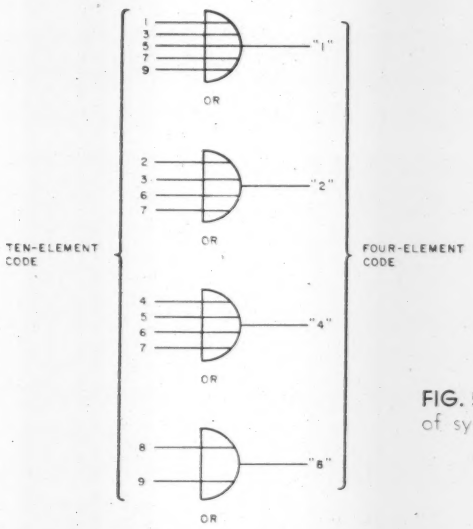


FIG. 4. CONVERTING DECIMAL input into binary-coded decimal output by use of four "OR" gates.

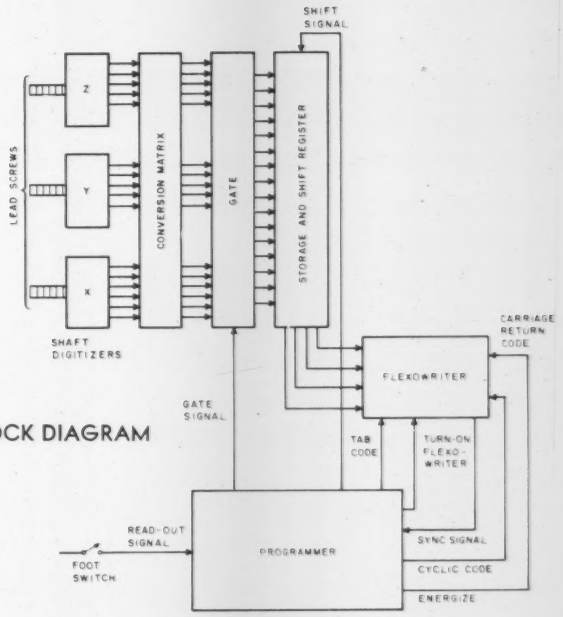


FIG. 5. BLOCK DIAGRAM of system.

over a large number of revolutions. As shown in Fig. 2, a number of "decade commutators" are connected by 10:1 gearing. Only one of the ten outputs of a commutator is energized at any given time. A basic problem with such a commutator is resolving the ambiguity when the commutator moves from one segment to the other.

This problem is solved by a dual-brush system (Fig. 3). The decision as to which brush is energized is made by signals derived from the next-lower-order decade. If the preceding decade has outputs 0, 1, 2, 3 or 4, only the leading brush is energized. If the preceding decade output is 5, 6, 7, 8 or 9, only the lagging brush is energized. Thus when the preceding decade output goes from "9" to "0" the applied signal shifts from the lagging brush to the leading brush, making a positive and unambiguous step.

Another means must be employed to resolve the transfer ambiguity in the least-significant decade because there are no lower order signals available. A set of ten trigger circuits is used. Only one of the circuits can be "up" at a given time. The units-decade commutator drives the trigger circuits, which "remember" the correct output when the commutator brush is moving from one segment to another. The output is obtained from trigger circuits rather than the commutator segments.

Output of the shaft digitizers must be sampled and stored so that the operator can go the next reading while the recording is taking place. The basic storage element used is the flip-flop.

The basic requirement of the system is that 16 decimal digits of data will be accommodated. This would require 160 flip-flops if a decimal system is used. However, the 16 decimal digits can be stored in only 64 flip-flops by using conventional binary-coded decimals, or 8-4-2-1 code.

The information is converted from the ten-element input circuit to the four-element coded form by a set of logic switching "OR" elements (Fig. 4). For instance, an output is obtained from the first element of the four-element code (that carrying a weight of unity) when the input is 1, 3, 5, 7, or 9; an output is obtained from the "8" element only when the input is 8 or 9. Hence, if the input signal represents "9" the output is from both the "1" element and the "8" element, as desired.

Printout and Punchout

The Flexowriter printer and paper tape punch (Fig. 1) accepts binary-coded decimal codes and prints and punches simultaneously. The machine prints and punches only one decimal digit at a time. Therefore digits are supplied sequentially.

The programmer (Fig. 5) generates the gate signal transferring the shaft digitizer outputs into the storage register upon a signal from a foot switch closed by the operator.

After gating, the programmer turns on the Flexowriter, starting the print-out and punch-out process.

The programmer shifts the information one place in the shift register upon receipt of a signal from the Flexowriter to the effect that the print and punch operations for a particular decimal digit have been completed.

The programmer counts the shifting operations. Periodically, and according to a prearranged pattern, it places into the Flexowriter a "tab" signal to give spaces between the different coordinate values. The programmer also determines when a total of sixteen digits has been printed. Then it introduces a "carriage-return" code and stops the Flexowriter.

After a certain number of complete print and punch cycles, the programmer directs the Flexowriter to proceed independently and record from a so-called cyclic tape, a tape loop which carries a number of constants, identification values, etc. The programmer senses the end of this operation and returns the readout system into readiness for additional readouts.

TAPE SYSTEMS

Magnetic tape equipments are used in many data systems, industrial and military. Here are a few typical systems, showing basic equipments and applications.

Project Datum

Electronic Engineering Company of California built this data-processing center incorporating equipment from Ampex Corp., Applied Science Corp. of Princeton, Electro Mechanical Research Inc., Bendix Computer, and others. The center was first studied by Ralph M. Parsons Co. for AFFTC, Edwards Air Force Base.

Table 1 lists the types of modulation and data frequency ranges used in this project. Fig. 2 shows the system; Fig. 1 is a block diagram of the digital portion.

TABLE I—TYPES OF MODULATION

RECORDING FORM	DATA FREQUENCY RANGE	SAMPLING RATE	DATA CHANNELS (Per Recorder Track)
Airborne (Tape speed 15" per second)			
Pulse-Width Modulation	0-3 cps	20 per second	41
RDB/FM	0-330 cps	Continuous	7 thru 14
Wide-Deviation FM	0-2,500 cps	Continuous	1
Direct	100-25,000 cps	Continuous	1
Rocket Engine Test Station (Tape speed 60" per second)			
Pulse-Width Modulation	0-1 cps	10 per second	86
RDB/FM	0-2,100 cps	Continuous	7 thru 18
Wide-Deviation FM	0-10 kc	Continuous	1
Direct	100-100,000 cps	Continuous	1
High Speed Experimental Track			
RDB/FM	0-2,100 cps	Continuous	5 thru 18
Sine Wave	100-21 kc	Continuous	1
Telemetering			
Pulse-width Modulation	0-3 cps	20 per second	41
	0-4 cps	30 per second	26
RDB/FM	0-2,100 cps	Continuous	1 thru 18
Radar Phototheodolite			
Binary Code, 16 digits		10 per second	

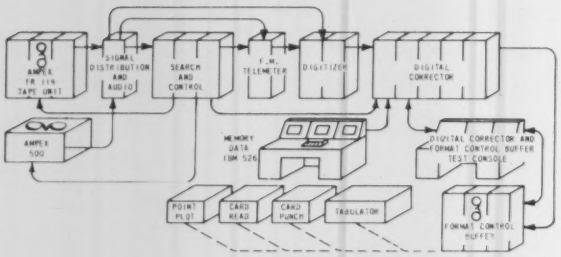


FIG. 1. DIGITAL portion of project datum.

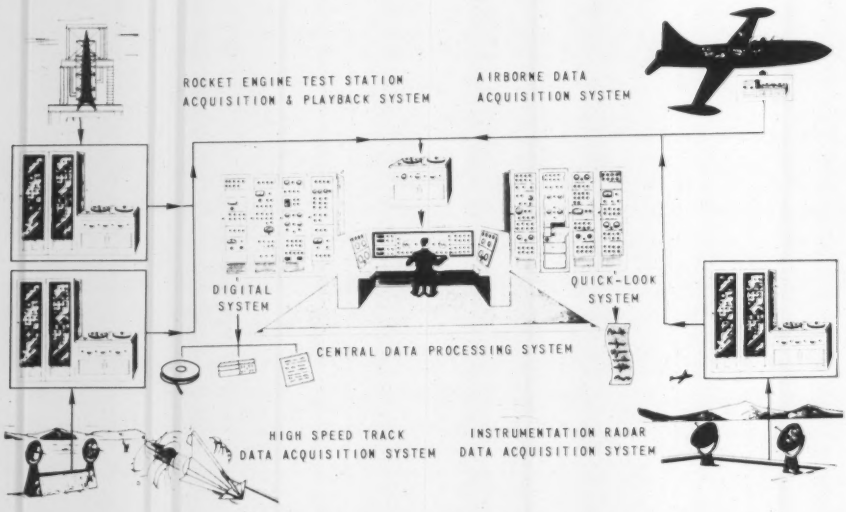

ROCKET ENGINE TEST STATION ACQUISITION & PLAYBACK SYSTEM
AIRBORNE DATA ACQUISITION SYSTEM
DIGITAL SYSTEM
QUICK-LOOK SYSTEM
CENTRAL DATA PROCESSING SYSTEM
HIGH SPEED TRACK DATA ACQUISITION SYSTEM
INSTRUMENTATION RADAR DATA ACQUISITION SYSTEM

FIG. 2. PROJECT DATUM system includes rocket-engine test data, airborne data acquisition system, high-speed track data system, and instrumentation radar data system.

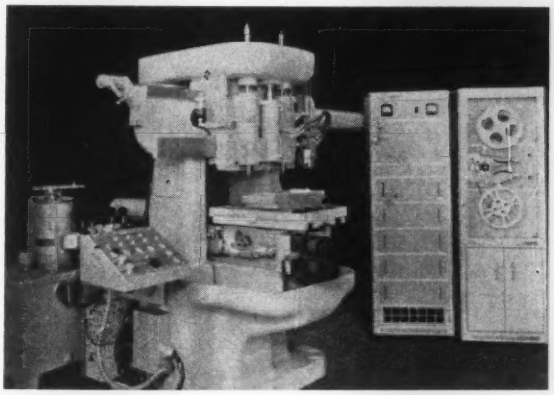


FIG. 3. NUMERICAL CONTROL SYSTEM on Morey 12M Profiler.

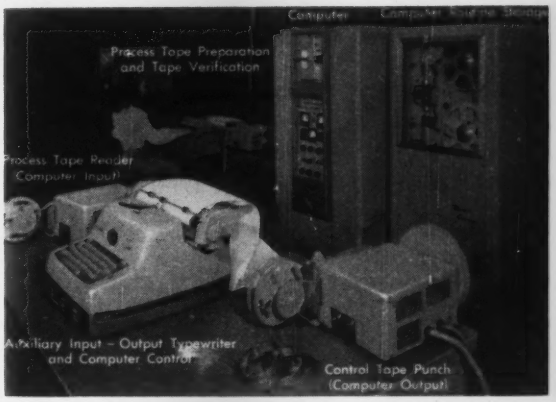

Computer
Process Tape Preparation and Tape Verification
Process Tape Reader (Computer Input)
Auxiliary Input – Output Typewriter and Computer Control
Control Tape Punch (Computer Output)

FIG. 5. G-15 receives data from magnetic tape and prepares punch tape.

Machine-Tool Control

The True-Merical ACA Control System (Fig. 3), controls machine motion by a magnetic tape. The coded instructions from the tape actuate electric motors that operate conventional hydraulic servo-mechanisms. These actuate the normal traversing and actuating mechanisms such as saddles, spindles, beds and tables of the machine.

The chain of command (Fig. 4) is from the magnetic tape through the power amplifiers to the synchronous motors, and from the motors to the precision lead screw to the four-way transfer valve.

A series of spaced magnetic pulses are recorded on parallel tracks along the length of 35-mm magnetic tape. A reel containing two thousand feet of the magnetic tape can furnish two hours of machine time. Each track corresponds to specific machine axis or action, with the exception of the reference track which serves as a time base for the complete system. The Magnasyc Corp. provides the electronic controls of the system; True-Trace Sales Corp. provides the hydraulic elements plus installation.

A magnetic tape handler is used also in the system shown in Fig. 5, which prepares a control tape for a numerical machine-tool control system. As thousands of calculations are involved in the preparation of such a control tape, a general-purpose electronic digital computer (Bendix G-15) is used, with many computer routines already available for specific machining operation. The routines are known as COMPAC (Computer Program for Automatic Control).

The steps in the process are as follows: From a blueprint or drawing of the part to be machined, the process planner first enters data manually, on a special form. A typist then enters this data into a Flexowriter, which prepares a punch tape; a second typing verifies this operation. The verified punched tape is then placed in a Process Tape Reader, which is attached to the computer. The computer COMPAC programs, which might be contour milling programs, are on the magnetic tape for easy and quick transfer to the G-15.

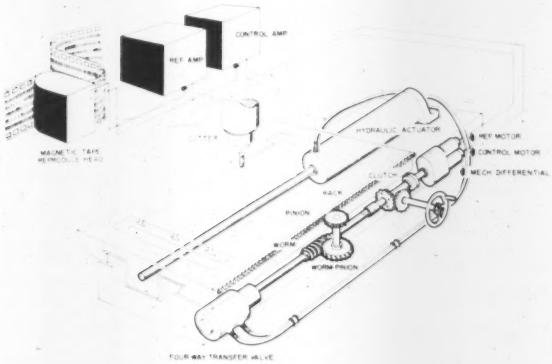


FIG. 4. MAGNETIC TAPE SIGNALS are amplified and brought to the synchronous motors, and from the motors to the precision lead screw to the four-way transfer valve.

On-Line Computing Facility

The Packard Bell Missile Impact Prediction System (Fig. 6) is a data processing system for missile tracking and impact prediction. The primary purpose of the system is to accept direction information from a Cotar tracker, convert this information into a form compatible with a general-purpose digital computer (Bendix G-15), compute the missile position and impact point, and present the resultant information on four plotting boards. The system records the digital input on tape for later evaluation or simulation.

The system (Fig. 6) receives shaft rotation information which represents radar axes of x, y, and h. These vectors are converted to digital form, to obtain four numbers, 17-bits long, which represent direction. These are fed into the general-purpose computer, which establishes missile position and velocity. In addition, the computer predicts the position where the missile will land after the conclusion of the last thrust period. These computations are performed two times per second.

The four input variables are each digitized by a combination of two-shaft-position encoders—a 13-bit photoelectric encoder (the ADCON Digisyn) and a Giannini 8-bit C-701 mechanical encoder.

A 50-microsecond pulse is used to sample all eight

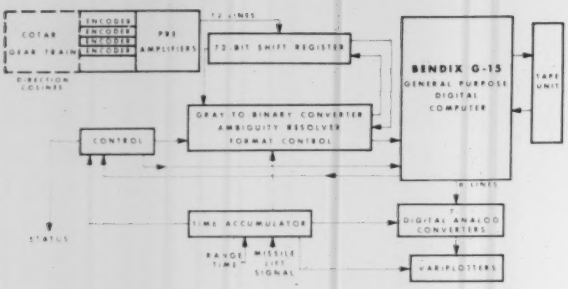


FIG. 6. PACKARD-BELL system.

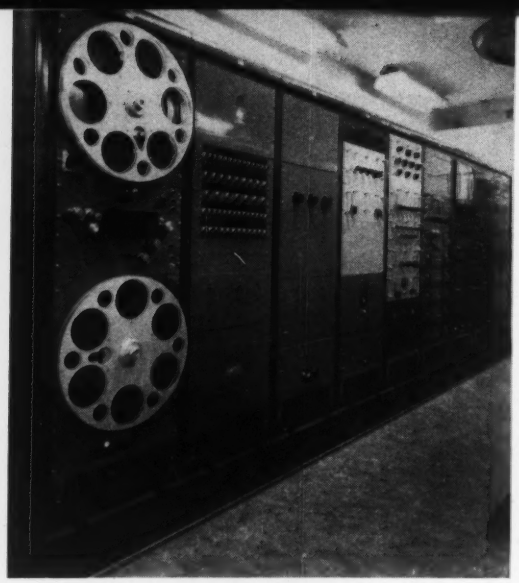


FIG. 7. REGULUS data facility.

encoders simultaneously, and the resultant 62 bits of information are transferred, in parallel, to 72 one-shot multivibrators. The new type ADCON preamplifier employed yields 10 ± 5v, and so eliminates the need for shapers or amplifiers external to the encoder.

The digital-to-analog converters are standard Packard Bell Multiverters, Model M2D-13. These are solid-state devices which operate in less than 10 microseconds. In view of the over-all accuracy requirement of the system, a conversion accuracy of 12 bits and its associated sign (+ or −) has been chosen. This yields a conversion accuracy containing only half the error produced by the plotting boards.

CVA Regulus

The automatic data processing facility at Chance Vought Aircraft, Inc. (Fig. 7), can reduce a maximum of 24 channels in the time required for a flight. All input is by ¼", ½" and 1" magnetic tape; output is an analog trace. The equipment is tabulated in Table 2.*

"Speedlock" holds tape speed within one part in 5000 via a 60-cps signal on tape. Flutter compensation has phase and amplitude adjustment. Noise is reduced by a factor of ten.

Vibration analysis equipment breaks vibration data from 20 to 20,000 cps into octaves for direct recording of acceleration *vs* time for each octave.

Accuracy usually is within 2%; 1% is possible. Output values at the selected break points are accurate to within 1% of full scale, and to within 0.5% when change of slope is not more than one.

Equipment includes three channels of AM; two channels of wide-band FM; one PDM circuit.

*Report is dated 22 November, 1957. Other equipment are now commercially available also.

TABLE 2—EQUIPMENT LIST

Abbreviations used in table:
Electro-Mechanical Research Inc.—EMR
Applied Science Corp. of Princeton—ASCOP
Berkely Division, Beckman Instruments—Berk/Beckman
Consolidated Electrodynamics Corp.—CEC
Chance Vought Aircraft—CVA
Lambda Electronic Corp.—Lambda
Electronic Engineering Company of California—EECO

Tape System—Ampex S-3577
Subcarrier Discriminator—EMR Model 67F
Tape Speed Compensator—EMR Model 96F-12
Switch Panel—EMR Model 56-1666
Calibration Decoder—EMR Model 56-105D
Calibrator-Servo—EMR Model 56-106A
Monitor Scope—ASCOP MMS-17
Distribution Panel—ASCOP MCP-5
Sweep Generator—ASCOP MSG-2
Power Supply—ASCOP MPS-17
Power Supply—ASCOP MPS-2
Channel Selector—ASCOP MCS-2
Channel Selector—ASCOP MCS-3
Control Unit—ASCOP MCV-1
Power Supply—ASCOP MSP-1
Output Translator—ASCOP MOT-2
Operational Amplifier—Berk/Beckman 10411
Power Supply—Berk/Beckman 1011
Function Generator—Berk/Beckman 10732A
Function Generator—Berk/Beckman 10722B
Power Supply—Berk/Beckman 1016
±100 Volt Reference Supply—Berk/Beckman 1015
Digital Voltmeter—Electro-Instruments MDV-1
Photo-Sensitive Recorder—CEC 5-119R
Direct Writing Recorder—Sanborn 156-100BW
Dual Channel DC Amplifier—Sanborn 2900V
Oscilloscope—James Miller 3" C.R.T.
Oscilloscope Amplifier—CVA/CVXOS-5
Switching Unit—CVA/CVXSA-35
Time Demodulator—CVA/CVXRP-3
Speedlock Demodulator—CVA/CVXRP-4
Voice Demodulator—CVA/CVXRP-2
Vibration Amplifiers—CVA/LE40-057
Vibration Detectors—CVA/LE40-058
OOSCI Converter—CVA/CVA CVCV-74
Power Supply—Lambda 62M
Remote Control Panel—CVA/CVXC-25
Output Signal Patch Board—Audio Development PJ 343 (double), PJ 343 with PJ 339 Jacks (single)
Blowers—ASCOP/APSI-MBP-1
Zero Suppression—CVA/CVXCV-73
Vacuum Tube Voltmeter—Hewlett-Packard 400D
EPUT Meter—Berk/Beckman Model 7150
Telemeter Test Oscillator—Hewlett-Packard Model 200T
Galvanometer Control Panel—EECO ZA50063
Galvanometer Damping Unit—EECO ZA-3924

Welding a Thermocouple Junction

C. E. MOELLER, Midwest Research Institute

IN a particular research program, it was necessary to know the temperature variation of the surface of a platinum sheet when exposed to high-velocity gases of varying temperatures. As the heat flow through the sheet was considered to be uni-directional, knowledge of the temperature variation at a plane in the sheet, parallel to and a known distance from the exposed surface, could be used to calculate the surface temperature. The region in which the temperatures were desired was approximately 0.100" in dia. Hence, any device to measure these temperatures was to be less than 0.100" dia.

It appeared that a thermocouple attached to the opposite surface of the sheet was a practical solution. The platinum sheet itself would be one of the metals of the thermocouple; a 0.010"-dia platinum/platinum-10%-rhodium wire (the other metal) welded to the sheet would be the other metal of the couple.

The parameters for resistance welding are contact pressure, voltage and time duration of applied voltage. Fig. 1 shows the welding fixture and the means for controlling the various parameters.

In order to maintain a controlled set of conditions for the evaluation of the welding parameters, the contact area between the wire and the sheet must be the same for all welds. The most practical and reproducible technique for fabricating a standard head on the wire was found to be that shown in Fig. 2. Such a head on the end of the lead wire is shown in Fig. 3 as it is welded to the platinum sheet.

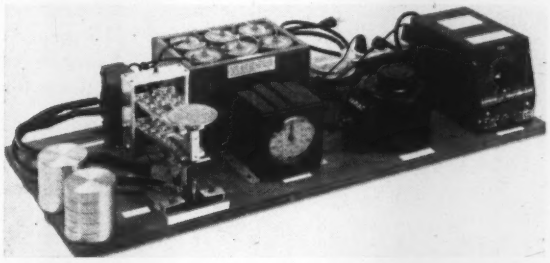
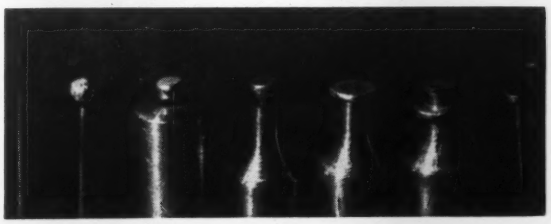


FIG. 1. Welding equipment for forming thermocouples and varying contact pressure, voltage, and time duration.

FIG. 2. Junction bead is formed on wire (left) by first heating and allowing metal to form a sphere. The sphere is flattened, first by emery cloth, then by pressing in a vise. Excess is sheared off to 0.040" dia around the punch die and the wire removed.



Welding Procedure

A series of welding experiments was carried out in which the voltage, time duration of voltage, and contact pressure were varied, one at a time. Voltages used were 60, 90 and 110 v on the primary of the 30-to-1 stepdown current transformer. Contact pressures of 3000, 6000 and 9000 psi were used. The method of evaluating the welded joint between the head of the wire and the sheet was by microscopic examination of the sectioned and etched weld (Fig. 4). Excessive heating must be avoided as it forms a zone of fusion between the two metals losing the well-defined thermal junction required. Insufficient heating will not join the entire surface area of the head to the sheet.

Normal crystals of cold-rolled platinum sheet have long fibrous structures. An annealing temperature of about 1500°F relieves the deformed crystal and enables the hexagon structure of the annealed platinum crystal to form. To prevent extremes of heating due to variation of initial contact resistance, the optimum welding conditions are those that, on the average, produce a zone of stress-relieved crystals extending in the platinum sheet to approximately half its thickness.

Extraordinary reproducibility for the technique is reported by the Diamond Ordnance Fuze Laboratories, where a group of the prototype thermocouples produced by this welding technique was statically calibrated.

FIG. 3. Closeup of thermocouple welded to platinum sheet.

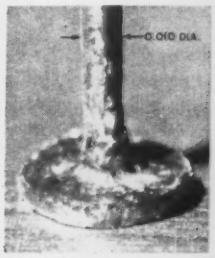


FIG. 4. Cross section of thermocouple shows heat penetration by presence of stress-relieved platinum crystals in the cold-worked platinum sheet.

ELECTRONIC

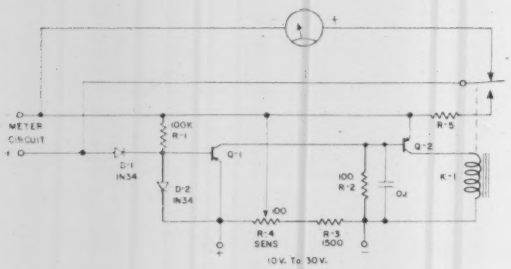
The circuit is the heart of all electronics. Here are 3 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

TRANSISTOR CIRCUIT PROTECTS SENSITIVE METER

The usual method of protecting a sensitive meter against overload (and possible damage) is to connect a sensitive relay in series with the meter. When the current in the relay coils rises to the overload value, the relay operates, opening the circuit to the meter. Disadvantages of this method of protection are (1) the sensitivity and calibration of the meter can be affected, and (2) the relay action can be so slow that a large surge of current can damage the meter before the relay operates.

In this circuit a more rugged (2-ma operating current) relay is used with a two-stage transistor (GE-2N107 PNP) amplifier to provide fast-acting protection for a 100-ua, 1000-ohm d-c meter. The circuit can be adapted for other types of meters.

Relay K-1 (Sigma 4-F) is normally un-energized, as shown, and the meter current flows through its contacts. When meter current rises beyond safe limits, K-1 is energized via the transistor amplifier, and meter circuit is opened, with the current flowing



through resistor R5, which is selected to have a value equal to or slightly higher than the meter resistance.

The coil of relay K1 is in series with the collector of transistor Q2. Q2 is normally cutoff by negative voltage at its base, developed by collector current flow in the normally conducting transistor Q1. Base of Q1 is biased in the conducting direction because the base is returned via resistor R1 to the sensitivity potentiometer R4, and is negative with respect to the emitter.

Emitter-to-base current of Q1, flowing through the 100k resistor R1, develops a voltage of the same polarity as the voltage across the meter, but larger in magnitude. Thus, when there is no overload, diode D1 is cutoff, as its cathode is more positive than its anode. Only a small reverse current flows in D1, providing negligible loading across the meter. When the voltage applied to the meter exceeds the overload value, diode D1 conducts, the base current of transistor Q1 is reduced, collector current of Q1 decreases, and the base of transistor Q2 becomes negative. Collector current of Q2 increases until the relay operates, removing the meter from the external circuit. When the meter is removed from the circuit it is replaced by R5, which should be equal to or slightly greater than the meter resistance.

Diode D2 was added to protect transistor Q1 from excessive base voltages which might damage the transistor. When the overload condition returns to normal, the circuit automatically reconnects the meter; the relay drops out at a current condition corresponding to about 75% of full-scale meter deflection, depending on the value of R5.

Sensitivity potentiometer R4 (100 ohms) is adjusted to determine the overload level at which the circuit operates.

Sensitivity of the circuit decreases with increasing temperature. If the sensitivity control R4 is set for relay operation at full-scale at 70°F, the meter will receive a 35% overload at 95°F. This is not considered serious; most meters are designed to withstand momentary overloads of 100%.

Speed of operation was checked using a 50-ua meter, by applying currents of 5 ma (100 times overload). In every trial the circuit removed the meter from the external circuit before the pointer reached the end of the scale.

An isolated d-c supply is required if the meter circuits must be floating. However, power supply current is small and the circuit is not voltage sensitive. Current drain at 22.5-v supply voltage is 16 ma. As most of this is drawn by bleeder R3-R4, values of these resistors could be increased to reduce drain for battery operation.

Q1 and Q2 are GE-2N107 PNP transistors; GE-2N43-A, of lower I_{co} also could be used.

Power supply: 10-30 v d-c; current drain 16 ma at 22.5 v.

Source: F. H. Blitchington, Jr., Western Electric Co., Greensboro, N. C.

TRANSISTOR VOLTMETER (TVM) HAS 100K OHMS-PER-VOLT SENSITIVITY

Base current of 10 ua is sufficient to drive the 100-ua indicating meter to full-scale in this instrument. Input resistance is thus 100K ohms/volt (compared with 20K ohms on the usual laboratory voltohmmeter that uses a 50-ma movement); thus d-c voltage measurements can be made with less loading of high-impedance circuits.

Four ranges (1, 10, 100 and 1000 v d-c full-scale) are provided; other ranges can be obtained by pro-

CIRCUITRY

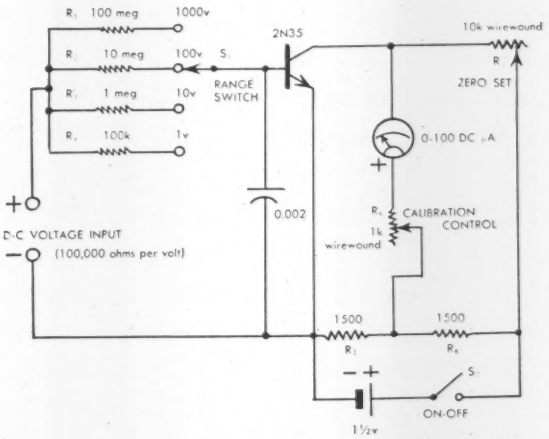
CHARLES F. KEZER

and

MILTON H. ARONSON

viding the proper multiplier resistors in series with the voltage range switch S1.

One NPN junction-transistor type 2N35 is used in the common-emitter connection to provide current amplification to drive the indicating meter. Cutoff collector current (I_{co}) of the transistor flows with the input circuit open, and would produce a zero error if not balanced out. Hence the indicator is connected to the voltage divider R7-R8 instead of directly in series with the collector.



To calibrate the instrument, zero-set rheostat R5 is adjusted for zero indication with the voltage input terminals open. An accurately known d-c potential of 10 v is then applied to the input, with range switch on the 10-v position. Calibration control R6 is then set to produce full-scale deflection. Remove the input voltage and check zero-setting, resetting if necessary. Full-scale calibration should be checked again, and the two adjustments repeated until the no-input reading and full-scale calibration are correct.

Voltage ranges: 1, 10, 100, and 1000 v d-c.

Input impedance: 100K ohms/volt d-c.

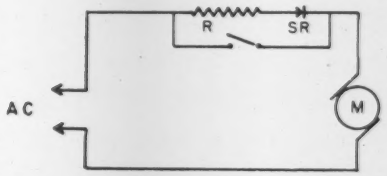
Power supply: 1½-v battery; quiescent drain is 0.5 ma.

Source: Booklet, 28 *Uses for Junction Transistors*, Sylvania Electric Products Inc., 140 Broadway, New York 19, N. Y.

BRAKING CIRCUIT FOR INDUCTION MOTORS

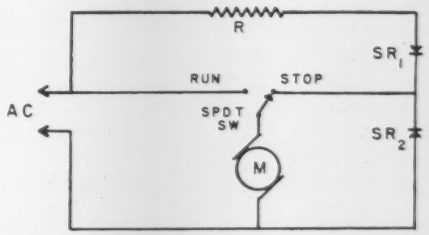
Small induction and synchronous motors can be stopped more quickly by passing direct current through the windings. This dynamic braking is not always as effective as mechanical braking, particularly with large inertia loads. However, dynamic braking has the advantages of simplicity and low cost.

In the first braking circuit shown, the motor driving current bypasses resistor R and rectifier SR when the switch is closed. When the switch is opened to stop the motor, however, rectified current flows in the motor windings to produce braking. Resistor R limits the direct current to prevent motor overheating. Value of R has to be determined for the particular motor used.



The one-diode circuit shown has limited holding power, and allows the motor to "creep" because the braking current is pulsating. Also, audible 60-cycle noise is produced, which is sometimes objectionable.

These objections are largely overcome by the addition of another diode rectifier as shown. When the switch is thrown to the "stop" position, alternate half-cycles of



current flow through the motor via rectifier SR1. When the line voltage reverses, however, SR1 is non-conducting and the collapsing magnetic field of the motor generates a voltage of polarity (positive) to maintain the current flow. Rectifier SR2 provides a path for this current flow. Thus, a much steadier flow of current is obtained during braking. Current in rectifier SR2 has been found to be about 10% less than in SR1; hence the same type rectifier can be used for both.

Still greater braking power can be realized by using an incandescent lamp of the proper wattage instead of the fixed resistor R. As the resistance of tungsten lamps is low when cold and rises with temperature, the lamp permits a heavy initial inrush of current, reducing current to a lower "hold-in" value as the lamp heats up. A time-delay relay also could be used to reduce braking current, switching to a higher value of resistor R to achieve the same purpose.

Source: H. E. Guttman, Dept. of Psychology, U. of Washington; also *Review of Scientific Instruments*, June, 1958.

Process Control Systems

FRED D. MARTON, Instruments Publishing Company

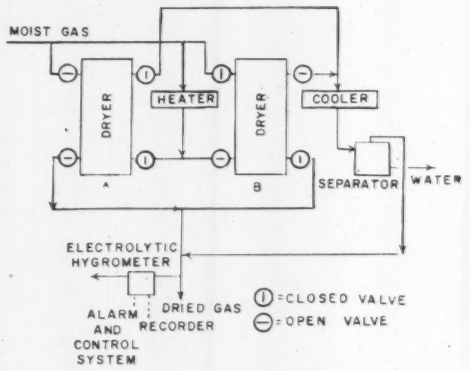
HYGROMETER CONTROLS DEHYDRATOR

Reliable control of the moisture content in gas streams is essential to the operation of natural-gas plants. Excess water reacts with the various hydrocarbons to form hydrates which can seriously impair plant operation. Furthermore, most sales contracts specify that the water content must not exceed seven pounds per million cu ft of gas.

A typical dehydrating system includes twin dehydrating towers so that one can be regenerated when desiccant is spent while the other is in use.

In the system shown, a Beckman Electrolytic Hygrometer, monitoring the drying cycle diverts the gas streams from one drying tower to the other whenever the water content increases, whether it occurs at the expected time or as the result of an abnormal loss in drying capacity. The hygrometer also provides a permanent record of the outlet-stream humidity, which can be used as a guide for evaluating the performance of the desiccant.

As only a small sample flow is required for the hygrometer, a bypass system is used. The sample stream is regulated at a convenient temperature between 32°F and 212°F and introduced into the hygrometer with a 10-to-100-psig inlet pressure and a flow rate equal to or greater than 100 ml/min.



Use of the hygrometer saves desiccant.

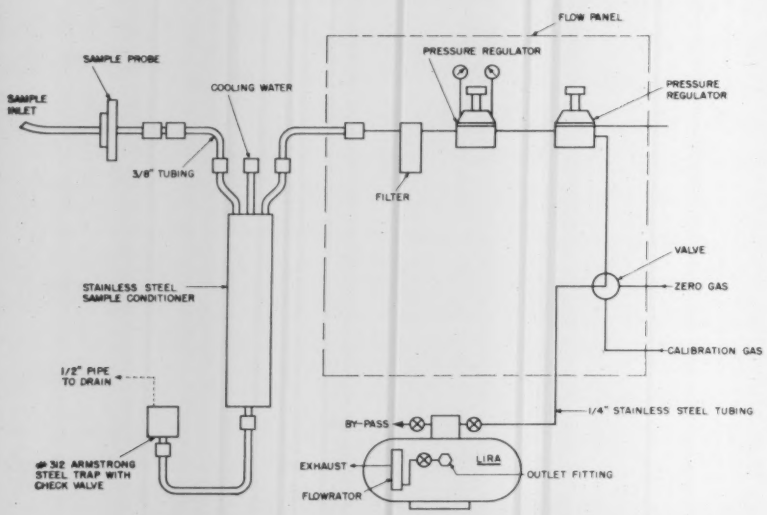
Source: Beckman Instruments, Inc., Scientific and Process Instruments, Div., Fullerton, Calif.

SYNTHETIC-AMMONIA PLANT USES CONTINUOUS INFRARED ANALYSIS

Synthetic ammonia can be produced by partial oxidation of natural gas or refinery gas having a high concentration of methane. In this new type of process, the measurement of the residual methane immediately after the reformers is of extreme importance because the concentration of methane is an indication of reaction efficiency.

At the Mississippi River Fuel Corporation Ammonia Plant at Selma, Mo., there are five generators and the product gas from any of these units can be continuously analyzed by one of two LIRA Infra-Red Analyzers, using a special sampling system.

The sampling system consists of a special probe mounted in a 6″ line, a stainless steel watercooled sample conditioner with a steel release trap, filter, pressure reducer, and regulator. As the sample stream is steam saturated at 400 psig, the sample conditioner is made of welded steel. The sample is cooled by the outside water jacket and the condensate collects in the bottom of the tower. As the condensate builds up, it causes the steel trap to open and the steam pressure forces the condensate out.



Basically the LIRA consists of two infrared light sources, two stainless steel cells called the sample and comparison cells, a V-shaped unit called the beam combiner, a detector cell, an amplifier and a recorder. The infrared sources are small ribbons of nichrome which are heated electrically to about 1300°F to emit infrared. The light beams are directed into the two cells and then into the beam combiner where they are converged and are directed into the detector cell. A shutter alternately blocks each beam thereby permitting comparison of the amount of light reaching the detector through the two cells. If the gas to be analyzed absorbs infrared, there is an unbalance between the two beams. This unbalance is measured in the detector by capacitance, creating an electrical impulse which is amplified and fed to a recorder.

Recorder range is 0—1% methane.

Source: Mine Safety Appliance Co., Pittsburgh, Pa.

TWO-ELEMENT PILOT-OPERATED FEEDWATER CONTROL SYSTEM

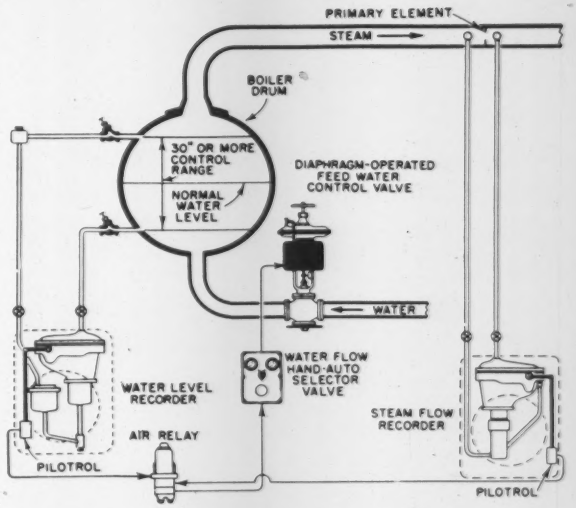
The two-element pilot-operated system is more stable than a single-element system.

Level is measured by a differential device connected to the boiler drum, and *steam flow* is measured by a flowmeter connected to an orifice or nozzle installed in the main steam line. Each of these devices is connected mechanically to a pilot valve having set point and proportional band adjustments (Pilotrol), the outputs going through an Averaging Relay (Standatrol) which provides reset action. From the Averaging Relay, the air signal goes through a Hand-Automatic Selector Valve, and to the feedwater regulating valve installed in the boiler feedwater line.

With this type of control, the primary influence is *steam flow*, which acts to open and close the feedwater regulating valve as the demand for steam increases or decreases. The level controller is then used as a readjusting control only, to maintain the level within the boiler drum at the proper value. This permits a broad proportional-band adjustment on the level controller, and the cycling in the feedwater system is reduced considerably.

As in the single-element self-operated, and single-element pilot-operated systems, *feedwater pressure control* ahead of the regulating valve is essential for optimum operation. A change in pressure ahead of the regulating valve will cause a corresponding change in feedwater flow to the boiler, which reacts on the level and back through the system in order to readjust the valve. Where erratic feedwater pressure exists, the level control will be called upon to do an abnormal amount of adjusting, with a consequent upsetting of the entire feedwater system. A 3-element system is then required.

Source: Bailey Meter Co., Cleveland, Ohio.



STEEL-ANNEALING FURNACE HAS ATMOSPHERE CONTROLLED BY MOISTURE

Terminology:

Carburizing: Addition of carbon to the surface of tool steel.

Carbon potential (of *furnace atmosphere*): Carbon balance of furnace atmosphere in relation to the carbon content of steel being treated. Sometimes called "carbon pressure."

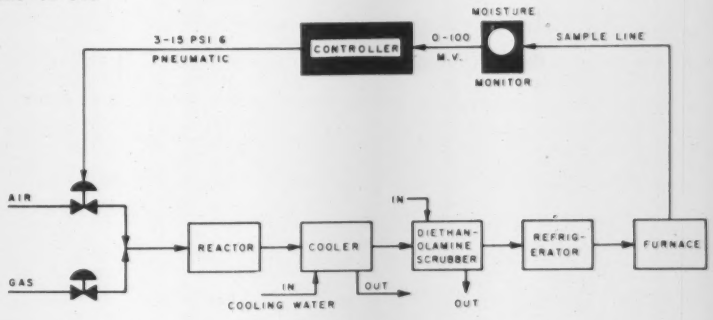
Carburizing is a widely used heat-treating process. In this circuit shown a moisture monitor assures that steel parts will have constantly uniform and reproducible properties by controlling the moisture content in the furnace. This in turn holds the *carbon potential* of the furnace atmosphere at a constant value.

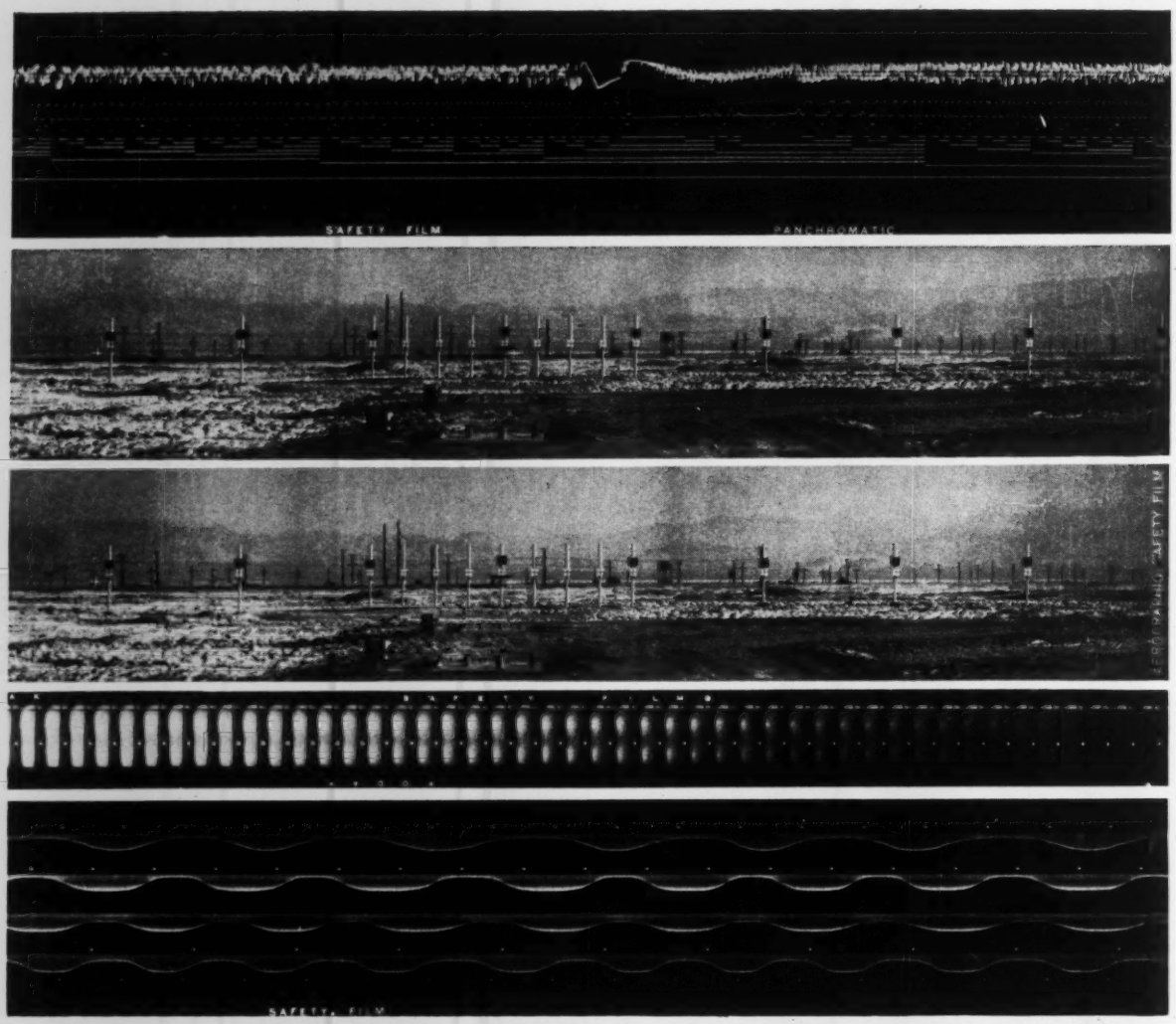
The composition of the atmosphere is maintained by controlling the *ratio of air to gas* by means of the sample flow system and control loop shown. Changing this ratio alters the amounts of hydrogen and carbon monoxide which exist in relation to nitrogen. As a result, moisture content (which is a direct measure of annealing potential) becomes a controlled variable and the combustion ratio becomes a dynamic variable that can be adjusted to achieve desired performance.

In operation, parts are placed in the furnace as it is brought up to temperature and are kept there until the desired depth of carburization is reached.

System and Equipment: This system can be characterized as a first-order system with an approximate dead time of five minutes. The moisture monitor is an extended-range electrolytic-type instrument (CEC Model 26-302) which determines moisture content over the dewpoint range of −100°F. to +65°F. The controller (Brown ElectroniK Air-O-Line, Model 152 P) has zero to 150% proportional band, automatic reset, and rate action because of the system's dead time. The final control element is a conventional single-seated air diaphragm control valve with linear characteristics.

Source: Consolidated Electrodynamics Corporation, Pasadena, Calif.





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DYNAMIC RESPONSE TESTING OF PROCESS INSTRUMENTATION

PART II–DEVICES WITH PNEUMATIC OUTPUT SIGNALS

THIS tentative Recommended Practice has been prepared as a part of the service of the Instrument Society of America toward a goal of uniformity in the field of instrumentation.

3.1 Test Signals

Sine wave and step tests as given below are recommended*. (The input span referred to here is that input signal that will drive the output signal through its full range.)

Signal No.	Test	% of Input Span*
1	Sine Wave	45% to 55%
2	Step	45% to 55%
3	Step	55% to 45%
4	Step	10% to 90%
5	Step	90% to 10%

*Peak to peak for sine waves

The test should start at a frequency low enough so that the magnitude of the output sine wave essentially equals that of the steady-state output for the same input, and there is essentially no phase shift between them (except if the device has pure integral or derivative functions). The frequency should be increased until the magnitude of the output sine wave is 10% or less of the steady-state value, or the phase lag is 300°. Generally speaking, a response test should cover a frequency span of at least three decades.

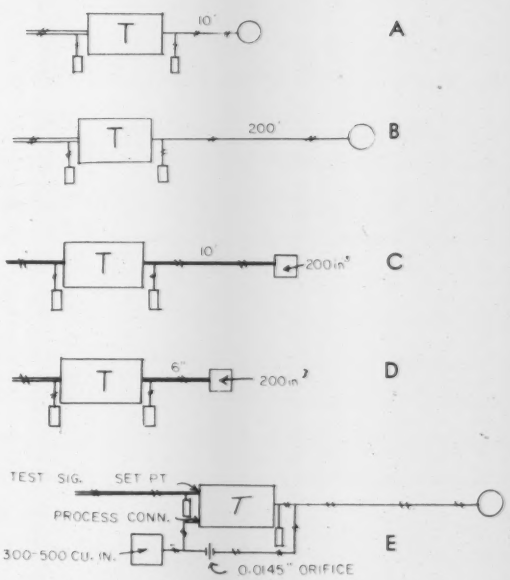
Care should be taken to vary the frequency in small enough increments to describe accurately abrupt changes in the response curve, particularly in the vicinity of resonant peaks.

3.2 Load Configurations

Five standard load configurations are recommended (Configurations A to E). Note that the recommended location of the pick-off point before the load will result in data which give the response of the device or system *alone* when coupled to the given load. To get the over-all response, it is necessary to combine the device or system response with that of the load.

(1) Configuration A

This configuration represents a typical close-coupled pneumatic device such as a field transmitter and a controller with no long branch lines.



(2) Configuration B

This load looks to the transmitter like a long transmission line, or a short transmission line with a long branch. The response at the transmitter is the same for either case. In using the data for a field installation, it will be necessary to add the effects of the particular load used.

(3) Configuration C

This configuration would represent the case of a large load such as a diaphragm motor on a particular device. It was not felt that another test with longer tubing and a large load was needed since a booster or positioner would normally be interposed if dynamic response was critical.

(4) Configuration D

This configuration represents a close-coupled large load such as would be seen by a device primarily intended to deliver pneumatic power such as a booster or positioner.

(5) Configuration E

This configuration is used to test the reset function in a pneumatic controller.

*Same recommendations are made for electrical signals.—Ed.

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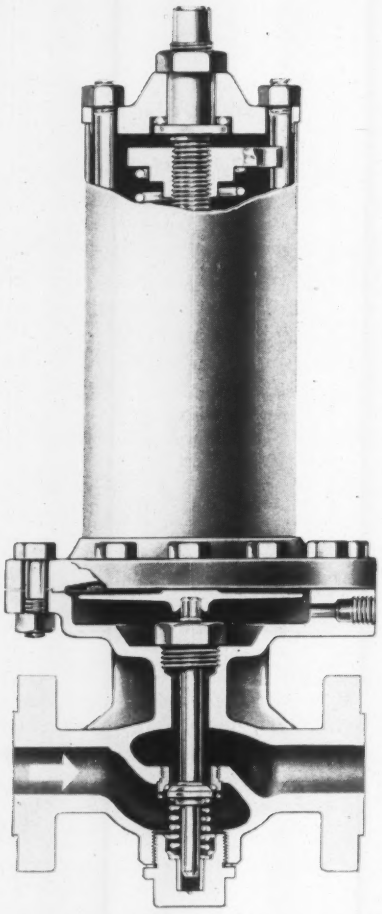
The new Leslie Topper self-contained pressure reducing valve offers a new level of accuracy, simplicity and low-maintenance service (see chart below). Key to this revolutionary valve is a piloting device which is entirely out of the path of steam. Because this mechanical pilot is sealed-off from the steam and all valve parts are designed without dirt-catching passages, the new Topper valve is ideal for both poor steam conditions and intermittent duty.

It can handle low-reduced pressures and is used in process lines, steam heat reducing stations and for make-up steam supply to heaters, gland sealing system and process equipment. You benefit from added reliability, plus the accuracy of a pilot operated valve and the rugged simplicity of direct operation. It means less shut-down time for maintenance, surer pressure control and increased plant efficiency.



SPECIFICATIONS

Sizes, Body Materials and End Connection:
½—2", cast iron, and bronze, screwed, 150 and 300 lb. bronze, flanged.
1—2" 125 and 250 lb. cast iron, flanged bodies.

Three Spring Ranges: *2-10 psi; 5-20 psi; 15-35 psi.*

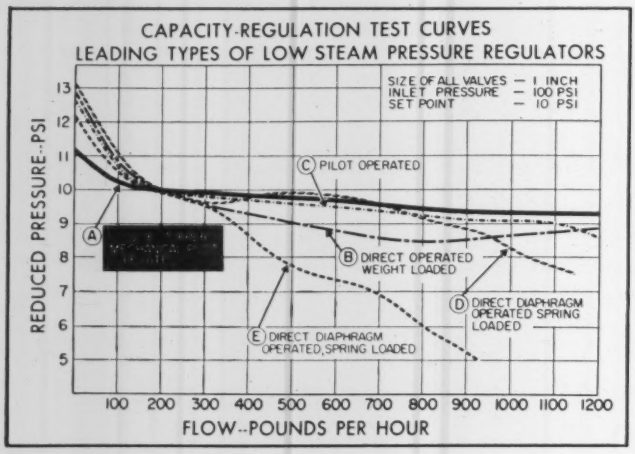
Long-travel metal diaphragm: *2 ply, phosphor bronze, Spiro-flex.®*

Main Valve: *Hardened 440C stainless steel.*

Seat Ring: *Stellited stainless steel.*

Stem Guides: *Gun metal bronze (top and bottom guided).*

Main Valve Spring: *Inconel.*



For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 582.

LC-8

For more information circle **74** on inquiry card.

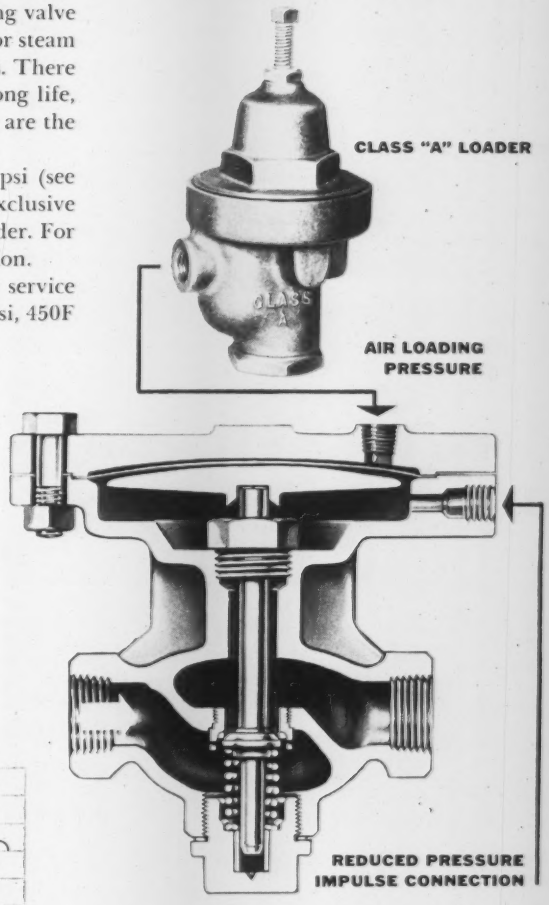
PRESSURE REDUCING VALVES

LESLIE AIR-LOADED REDUCING VALVE GUARANTEED MAINTENANCE-FREE FOR THREE FULL YEARS

New Leslie air-top GPK diaphragm operated, pressure reducing valve is guaranteed maintenance-free for three full years. Designed for steam heat or process steam application, it has only two moving parts. There are no seals, no stuffing boxes, no small dirt catching parts. Long life, long-travel diaphragm and hardened stainless steel main valve are the only parts that move.

You get accurate response even to flow changes as small as 0.1 psi (see chart below). This exceptional responsiveness results from exclusive diaphragm design and the accuracy of the simple Leslie air loader. For added flexibility, pressure can be adjusted from remote location.

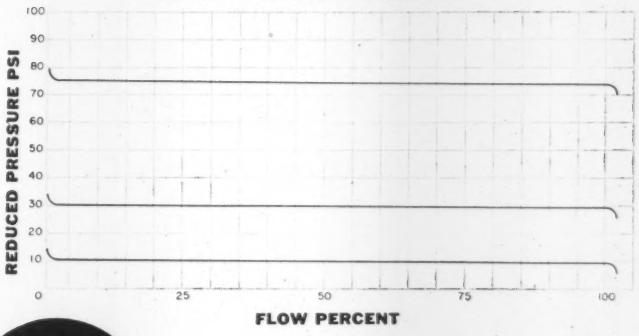
Especially desirable for poor steam conditions and standby service requirements, the GPK is suitable for steam service up to 250 psi, 450F and is available in ½" to 4" sizes.



SPECIFICATIONS

Sizes: *½ to 2", cast iron or bronze, screwed ends. 2½, 3 and 4", cast iron, 125 or 250 lb. flanged.*
Main Valve: *Hardened 440C Stainless Steel.*
Seat Ring: *Stellited Stainless Steel.*
Stem Guides: *Gun Metal Bronze (top and bottom guided).*
Main Valve Spring: *Inconel.*
Inlet Pressure Range: *0-250 psi, 450°F.*
Reduced Pressure Range: *0-85 psi with Class A loader, up to 249 ½ psi with any suitable high pressure loader.*
Minimum Pressure Drop across Valve: *½ psi.*
Available with manual opening device in sizes ½—1¼".

CAPACITY-REGULATION GRAPH



For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 561-B.

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Journal of the S C M A . . .

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Selecting Analytical Instruments *for* Process Applications

Should you use a process analyzer?

If a process analyzer is required, which of the available types is best for the job?

What will the manufacturer provide?

GEORGE S. TURNER
Beckman Instruments, Inc.

PROCESS ANALYZERS can be divided into two general classes—single- and multi-component analyzers. The single-component category includes optical-type analyzers (infrared, ultraviolet, and flow colorimeter), refractive index and dielectric constant analyzers, pH, oxygen and water analyzers. Multi-component analyzers include the mass spectrometer and gas chromatograph. Multi-component analyzers can be used for single-component determinations, and at least one of the infrared analyzers can be engineered for two-component analysis. By and large when two components are required, both types should be considered. The following presents the features of each type of analyzer.

Ultraviolet Analyzer

The ultraviolet analyzer uses the fact that some gases and liquids absorb energy in the ultraviolet region of the electromagnetic spectrum. The analyzer comprises (1) a source of ultraviolet radiation, (2) filters that pass only the wavelength region of interest, and (3) sampling cell and photosensitive detector. All elements can be made rugged and durable.

The two commercially-available ultraviolet analyzers operate with alternating signals, generated in one case by alternately comparing the radiation passing through the sample cell with that passing through a reference cell, and in the other case by alternately focusing radiation of two wavelengths (one absorbed, the other not absorbed by the component of interest) on the detector. The manufacturers claim an accuracy of better than $\pm 1\%$ of full scale for the ultraviolet analyzers.

Compounds which absorb ultraviolet energy are those which have a "chromophoric," or color-absorbing group. These include aromatic hydrocarbons, and molecules having conjugated double bonds (Table 1). Some of the best applications for ultraviolet analyzers are found in butadiene and synthetic rubber plants, where butadiene and isoprene (used in the manufacture of butyl rubber) are monitored. If the measured component is the only diolefin present, the analysis is specific and sensitive, as olefins and paraffins show virtually no absorption of energy in the wavelength regions used. Other applications are associated with aromatics, such as styrene and phenol. A feature of the ultraviolet region is that many solvents (including water) are quite transparent. Thus, analysis of liquid samples can be fairly straightforward.

Flow Colorimeters

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Journal of the S C M A . . .
SOUTHERN CALIFORNIA METER ASSOCIATION

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Selecting Analytical Instruments *for* Process Applications

Should you use a process analyzer?

If a process analyzer is required, which of the available types is best for the job?

What will the manufacturer provide?

GEORGE S. TURNER
Beckman Instruments, Inc.

PROCESS ANALYZERS can be divided into two general classes—single- and multi-component analyzers. The single-component category includes optical-type analyzers (infrared, ultraviolet, and flow colorimeter), refractive index and dielectric constant analyzers, pH, oxygen and water analyzers. Multi-component analyzers include the mass spectrometer and gas chromatograph. Multi-component analyzers can be used for single-component determinations, and at least one of the infrared analyzers can be engineered for two-component analysis. By and large when two components are required, both types should be considered. The following presents the features of each type of analyzer.

Ultraviolet Analyzer

The ultraviolet analyzer uses the fact that some gases and liquids absorb energy in the ultraviolet region of the electromagnetic spectrum. The analyzer comprises (1) a source of ultraviolet radiation, (2) filters that pass only the wavelength region of interest, and (3) sampling cell and photosensitive detector. All elements can be made rugged and durable.

The two commercially-available ultraviolet analyzers operate with alternating signals, generated in one case by alternately comparing the radiation passing through the sample cell with that passing through a reference cell, and in the other case by alternately focusing radiation of two wavelengths (one absorbed, the other not absorbed by the component of interest) on the detector. The manufacturers claim an accuracy of better than $\pm 1\%$ of full scale for the ultraviolet analyzers.

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strument departments and readily serviced by them. Another advantage is that the instrument can present a complete chromatogram of the stream when desired.

This instrument is finding popular acceptance in almost all applications involving multi-component analysis. Complex mixtures of hydrocarbons, both saturated and unsaturated, can be analyzed completely. Oxygen, nitrogen, CO and CO_2 are determined readily. Recent work has extended sensitivity to the parts-per-million range on some components. Present instruments will analyze mixtures having dew points up to 150°C.

What Will the Manufacturer Provide?

The customer can expect assistance in selecting and engineering the analyzer for his particular application. Manufacturers maintain application engineering departments thoroughly trained on a variety of instruments, and experienced in applying these instruments in all types of industrial plants. Some manufacturers provide assistance in sample handling. Engineers who specialize in sampling systems will make detailed recommendations for the specific problem.

Many suppliers include installation and start-up service in the purchase price of the instrument.

When to Buy

Process analyzers are definitely indicated in situations where frequent analyses are necessary or desirable, such as (1) atmospheric monitoring of toxic or flammable vapors, (2) protection of a catalyst from poisonous materials which might lead to its destruction, and (3) processes characterized by a short time-lag—that is, where the product is influenced quickly by changes in the feed or in other variables, and frequent adjusting is necessary. In case (3) it frequently is possible to obtain large and continuing returns on capital invested in an analyzer through improved production efficiency. The possibility of controlling the process by means of an analyzer is also an important consideration.

The relative costs of laboratory and plant analyses usually are not readily determined, and should be considered an important factor only when there is a large and clear difference. The process analyzer will provide many more analyses in a given time, and release laboratory facilities for more challenging and more interesting problems.

A much more important consideration in connection with the justification of analyzers is their "johnny-on-the-spot" feature. In times of plant upset, it is useful to have continuous indication of the changes which result from corrective action. This is particularly true of the recently-developed composition analyzers, such as the Gas Chromatograph, which permit taking a close look at the entire stream when required. Two separate incidents in the author's experience illustrate this point; both are associated with synthetic rubber plant operation.

In the first case, the production of a Butyl rubber unit suddenly fell off by about 10 tons/day. The dollar value of this lost production was approximately $4,000 per day. Laboratory analysis identified a foreign component which was affecting the efficiency of the catalyst, and traced it to its source. However, because the special analyses had to be programmed in with the regular work load of the laboratory, solving the problem required several days.

The second incident was in connection with a Butadiene unit. In this case the presence of a foreign component interfered with operation and made it necessary to shut down the plant for some days, with the loss in production amounting to about $20,000 per day. Once more, laboratory analysis identified the foreign component and corrective measures were taken.

Both of these incidents occurred some years ago, before Gas Chromatographs were available. Both streams are amenable to analysis by Gas Chromatography; if they had been equipped with this analyzer the foreign components could have been identified quickly.

European Success

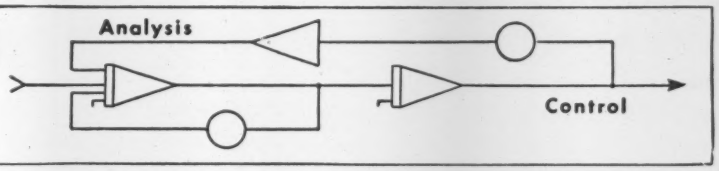
The total number of composition analyzers in use in this country runs to many thousands. However, the majority of these analyzers are relatively simple types. Industrial applications in which more complex (and consequently, more versatile) analyzers can be used to advantage have by no means been fully developed. This becomes apparent when we consider the extent to which analyzers of this type are used in Continental Europe and Japan, and the fact that a sizable fraction of the analyzers made in America goes to this market. In terms of capital investment, these analyzers represent a much larger item than they do in the domestic market. In addition, the capital outlay must be justified on the basis of products which are generally lower priced than in the American market.

One reason why more complex analyzers have not been utilized to greater advantage in American industry is the philosophy underlying their early development and sale. For example, when the infrared analyzer was being introduced to the market, it was commonly stated that the analyzer would be shipped ready for installation, and that continuous operation for a period of many months could be expected. This philosophy led process people to believe that no servicing would be necessary on their part, and that no detailed understanding of the analyzers was necessary. It also implied that little service from the manufacturer would be required. As a consequence, some analyzers were installed under circumstances which afforded very little opportunity for successful operation. This contrasts sharply with the European situation where, perhaps in part because of the large capital outlay, great efforts are made to insure proper installation and operation of the analyzer.

Successful operation of multi-component analyzers requires that the manufacturer provide assistance in installation and start-up, and instruction of the plant personnel who will be responsible for the analyzer. The purchaser is made to realize that proper functioning of the analyzer will depend to some extent on the ability of his personnel to make minor adjustments and to diagnose minor problems. Undoubtedly, this is a realistic and practical philosophy, and a fuller exploitation of analyzer potential should result.

Used effectively, process analyzers and controllers are real money-makers. Modern, relatively complex instruments require that the user be well informed on the principles and mechanism of their operation. Purchaser and supplier should work together to obtain top performance, and thus insure that the benefits offered by the analyzers are realized.

The SIMULATION COUNCIL Newsletter



John H. McLeod Jr., EDITOR

Suzette McLeod, SECRETARY

8484 La Jolla Shores Drive,
La Jolla, California

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Bits

Whattawegotcha this month? Well, we have some tips on sources of good information but few details herein.

Under **Pieces** we do our best to give you an idea of what went on at one Eastern Simulation Council meeting and one Western Simulation Council meeting. In this connection we talk about, but don't delve deeply into, the following subjects (discussed at the December ESC meeting, RCA Moorestown):

"Sampled-Data Techniques in Complex Simulation" by *C. G. Blanyer* (RCA).

"Analog Instrumentation of Transfer Functions by Inspection" by *E. A. Sevian* and *S. D. Cottrill* (both of RCA).

"A survey of Analog-Digital Conversion Techniques for the Analog Computer" by *Vincent R. Coates* (RCA).

"Analog Study of FM Discriminator" by *O. J. Palumbo* and *E. A. Sevian* (both RCA).

Then we comment briefly on the March 1959 WSC meeting on "Sampled-Data Systems" which was held at Lockheed MSD, Palo Alto where *Gene Franklin* (Stanford University) demonstrated the use of the Z-transform to analyze sampled-data systems, *Rubin Boxer* (Servomechanisms, Inc.) used the Z-transform to analyze the errors introduced by sampling a continuous function, and *Ed Goldberg* (Space Technology Labs) showed how to simulate a digital computer on an analog.

Finishing out **Pieces** are comments on the afternoon sessions of the WSC when *Bill Schart* (Convair-San Diego) described fundamentals of DDA's and General Electric presented a film on GEVIC at the DDA Council session, while the WSC conducted their discussion groups.

Also in this issue, under **Info**, is a restatement of the Simulation Council and Newsletter objectives for the benefit of those who have forgottten —or never knew—(and to justify the treatment of some of the material under **Pieces**).

Finally, we close with our **Puzzle Picture Contest**—a brand new irregular feature by our regular staff cartoonist, *Ernie Agee*.

Computer Events

Central Simulation Council

Date: October 1959
Place: McDonnell Aircraft Co., St. Louis, Missouri
Subject: "Computer Environment"

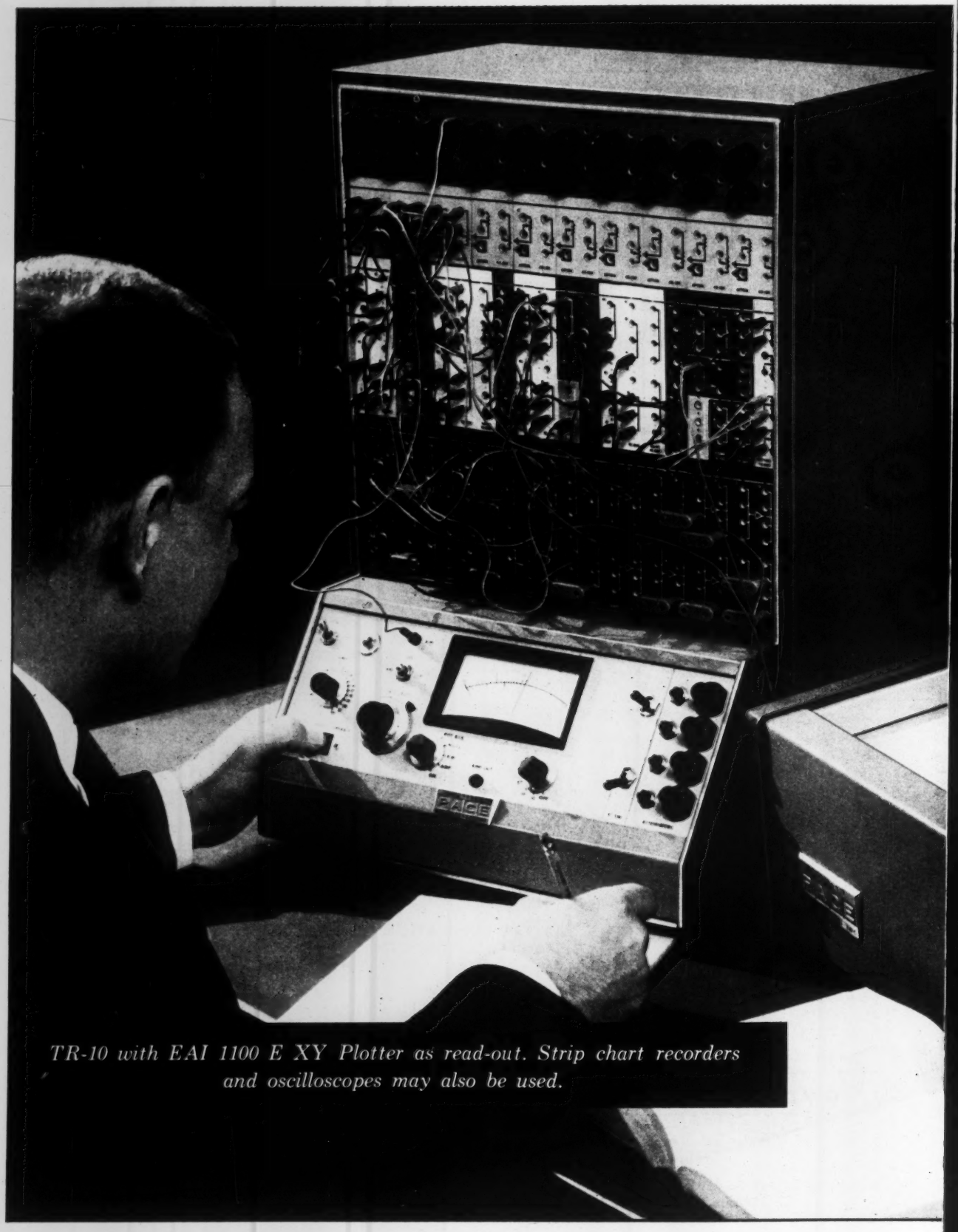
Pieces

EASTERN SIMULATION COUNCIL MEETING OF 15 DECEMBER ON SAMPLED DATA, A/D CONVERSION, TRANSFER FUNCTIONS, AND FM DISCRIMINATION

Bob Yeager (Electronic Associates, Inc., Long Branch, N. J.), then Chairman of the Eastern Simulation Council, has sent us copies of four papers presented at their 15 December 1958 meeting, but no other information as to what went on.

Blanyer on Sampled-Data Techniques

"Sampled-Data Techniques in Complex Simulation" by *C. G. Blanyer* (Hydel, Waltham, Mass.) states in the introduction that in a significant number of control systems data occur in samples primarily for one of two reasons—either the input information is available only at intervals, because of factors inherent in the detecting transducer or information-transmitting method, or delays must be introduced to accommodate data-processing operations. Although in certain instances the sample period is appreciable on a real-time scale, simula-



TR-10 with EAI 1100 E XY Plotter as read-out. Strip chart recorders and oscilloscopes may also be used.

THE *FIRST* ALL TRANSISTORIZED ANALOG COMPUTER

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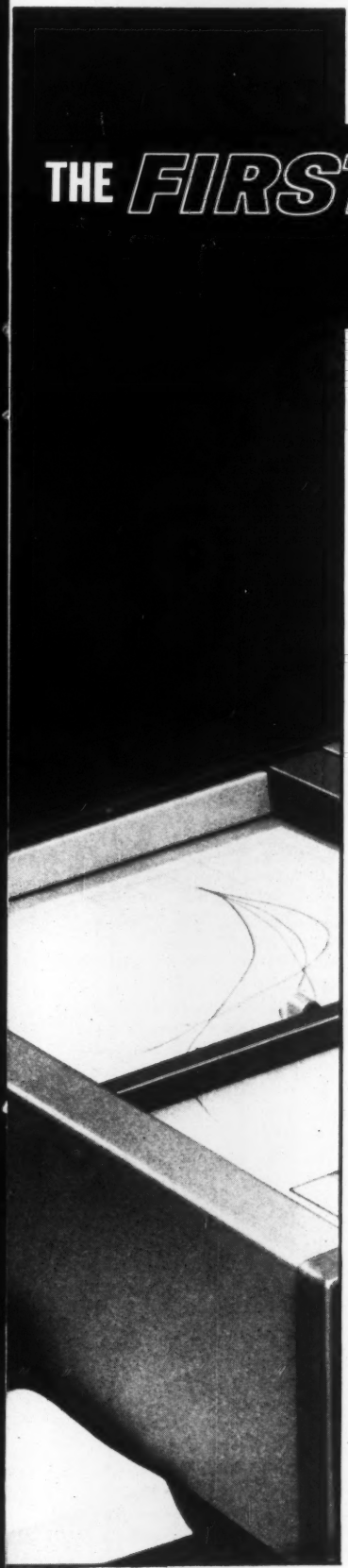

PACE TR-10 Eliminates Drudgery
Gives New Insight Into Engineering Problems

New transistorized computer puts the advantages of analog computation within reach of every engineer. This compact unit, 15″ x 16″ by 24″ high, is powered by 115 volts AC and can provide day-in day-out instant solution of your most vexing engineering problems. Even if you have never seen a computer before, you can learn to operate the TR-10 as easily as you learned to use a slide rule.

Gain New Insight to Complex Problems

Once the problem is set up on your computer, you simply turn a dial to feed in design parameters. The computer provides an instant by instant, dynamic picture of the effect of each change. You can study the inter-related effects of heat, pressure, flow, vibration, torque or any variable. And you can visually compare one with the other. You see problems in a new light – engineering data comes alive – insight into how new designs will work is obtained easier, faster. There's no need for recalculating every time you change a factor – simply turn the dial and see what effect it has on the solution.

Your "Personal Computer" for Higher Creativity

Because of its minimum size and extremely low price, the TR-10 can become your own personal analog computer. It helps to free you from routine drudgery. Permits you to gain first-hand experience with the power of analog techniques, and convert more of your time to *creative engineering.*

Test New Ideas or Designs

New ideas that were too costly to try before are now practical. Any possible combination of factors can be tried. You can design virtually to perfection and have a permanent, visual record of performance. All this can be done before building pilots or prototypes. As a result, "cut and try" expense is drastically reduced.

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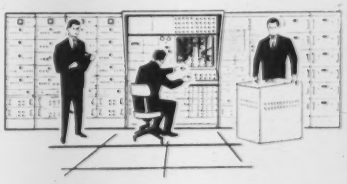

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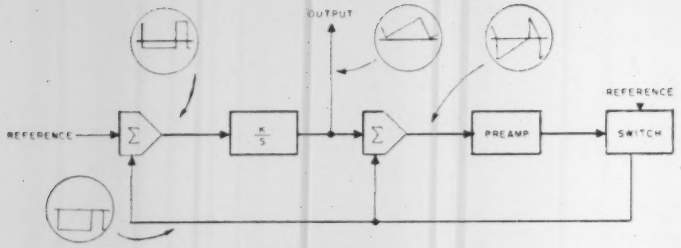

FIG. 1. **SAWTOOTH** timing generator.

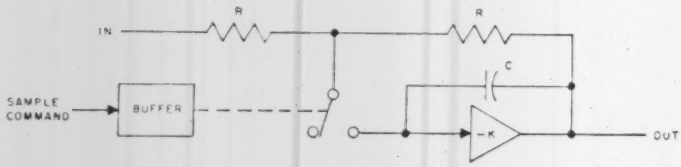

FIG. 2. **PRECISION** sample-and-hold.

tion frequently must be carried out with an expanded time-scale in order to investigate the properties of fast-sample systems.

Special requirements are placed on analog-computing equipment in the simulation of sampled-data systems. First, many computing components must be characterized by wide-band response for this service. Samples of data must be established during elapsed times which are brief in comparison with holding periods, which in turn tend to be shorter than the time constants of system elements. On the other hand, the holding process common to sampled-data systems requires good low-frequency (and in particular, zero-frequency) performance from many of the same components. The problem is intensified if the samples are intended to approximate impulses, and/or if the holding periods are variable in length with the result that some of them may be very long.

A second special requirement on sampled-data simulation equipment is the necessity for providing logical operations. Counting and decision-making procedures may be necessary for the timing and processing of data pulses. Furthermore, the time-quantized (and sometimes magnitude-quantized) nature of the sampled data may lead to the application of techniques of numerical analysis in the system which must be reproduced by simulation. Many extensive analog facilities are severely limited in this regard.

Mr. Blanyer goes on to say that his paper describes a selection of techniques and equipment used successfully in a large-scale analog-computing facility in the simulation of a variety of sampled-data guidance and control systems. In part the procedures are adaptable directly to typical analog installations; however, certain pieces of equipment referred to were developed specifically for sampled-data simulation.

Thereafter the paper clearly and methodically discusses methods of generating the Sample Command, giving one circuit (Fig. 1) about which it states: "With this system the waveform is controlled in both upward and downward directions, and switching occurs at predetermined points at both limits of the excursion; hence individual cycles are essentially independent, and cumulative errors do not occur." A circuit illustrating a "Conditional Sampling Circuit" used in a hypothetical search sonar, where substantially more complex logical operations are required, was also shown and duscussed.

"Sample-and-hold Devices were illustrated and discussed at some length, including a "Precision Sample-and-hold" circuit (Fig. 2) and a "Derivative Sampler" circuit.

The paper* closed with a discussion of the effects of noise on the systems.

*Probably available from the author—Ed.

Sevian and Cottrill on Transfer Functions

"Analog Instrumentation of Transfer Functions by Inspection," by *E. A. Sevian* and *S. D. Cottrill*, may or may not have caused discussion at the Eastern Simulation Council meeting, but it certainly did at Convair-San Diego and Astronautics! The paper presents a technique for solving, on the analog computer, transfer function equations of the type:

$$F(s) = \frac{e_o}{e_{in}} = K \frac{a_m s^m + a_{m-1} s^{m-1} + \ldots\ldots + a_1 s + a_o}{b_n s^n + b_{n-1} s^{n-1} + \ldots\ldots + b_1 s + b_o}$$

The presentation is clear, and the technique certainly looks as if it would solve the problem—but why? Undoubtedly that question has an answer; but your Ed. certainly couldn't find agreement on it in his area.

It would seem that the transform calculus and analog computers are to some extent competitive. They both offer means of solving sets of differential equations which describe the dynamics of physical systems. For an analytical solution the transform is a powerful tool; for a machine solution the analog computer is.

It is true that because of the widespread use of transforms for the analysis of feedback control systems, many engineers now think in transform notation. It was therefore suggested that perhaps system dynamics might sometimes be specified by a transfer function of the type given, in which case it would be convenient to mechanize it in that specific form on the analog computer to make performance studies. On the other hand, even when transform notation is used to describe the operation of a system, separate transfer functions of the individual components are most often used. These transfer functions of the individual components are usually of lower order and easily set up on the computer. To combine them into one over-all transfer function of the system will in most cases be laborious and time-consuming. Furthermore, of importance to those concerned with hardware, is the fact that this extra step would make any analogy between the computer and the physical system unrecognizable.

Mechanizing the over-all system transfer function per se can, however, save computer equipment, and according to *Steve Paine* (Convair-

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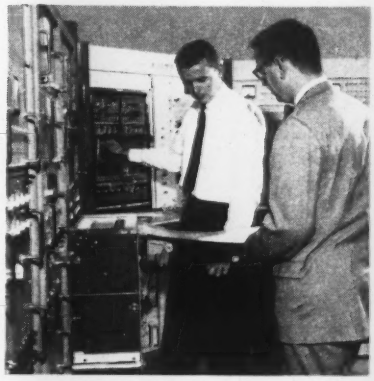

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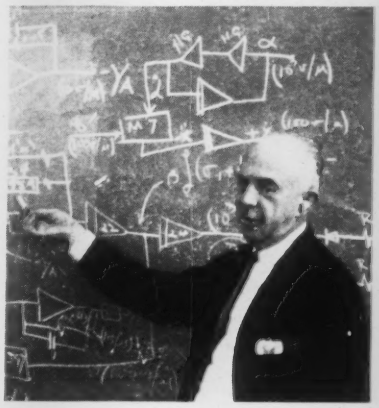

Kenneth Tuttle, director of the Computation Center, is a recognized authority in the field of analog computation. For further information on services offered, write or phone Mr. Tuttle at the EASE Computation Center, 305 Parkman Ave., Los Angeles 26, DUnkirk 2-2100. A detailed 4-page facilities brochure is available on request.

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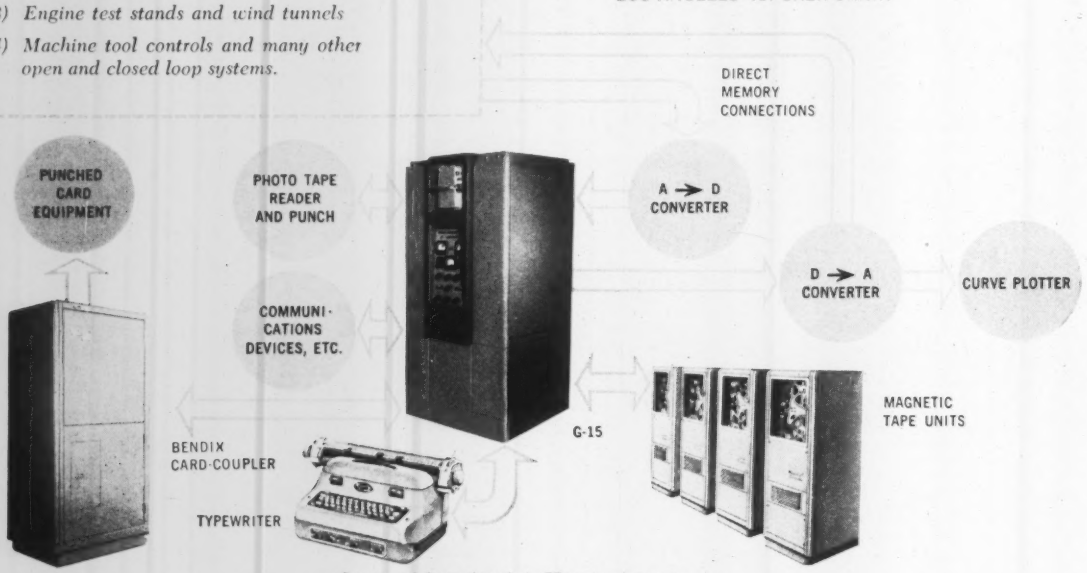

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San Diego) becomes important enough to make this a significant technique when attempting to simulate a large problem on a comparatively small computer. Sevian and Cottrill's paper therefore is recommended to those who might have an occasion to mechanize:

$$F(s) = K \frac{\sum_{m=o}^{m} a_m s^m}{\sum_{n=o}^{n} a_n s^n}$$

Coates Surveys A/D Converters

"A survey of Analog-Digital Conversion Techniques for the Analog Computer" by *Vincent R. Coates* (RCA, Moorestown, NJ) might more aptly be described as an introduction to the simulation of digitizing devices.

A brief introduction to the nature of sampling and quantizing was given to provide an intuitive appreciation of these phenomena for the programmer who, confronted with the need to simulate them, has had no previous experience in their use.

For a minimal understanding of sampling theory, the Sampling Theorem for Sinusoids, "If a signal f(t) is sampled at time t = ... , —2T, —T, p, T, 2T, ... , the frequency components of the signal greater than π/T radians per second cannot be distinguished from frequencies in the range 0 to π/T radians per second", was explained and restated as: "It is necessary to take more than two points per cycle of the highest significant frequency component in a signal in order to recover that signal." Therefore, if we are interested in analyzing the low-frequency components of a signal containing high frequencies, the high frequencies must be eliminated by filtering before sampling. It is important to note that the sampler does not simply filter out the frequencies higher than twice the sampling frequency. They are partially carried through, with the net result of distortion of the input and, hence, a loss of information.

The design of the holding filter and the process of quantizing are then discussed. Computer circuits for their simulation complete the paper.

The following references were given:

1. Susskind, A. K., "Notes on Analog-Digital Conversion Techniques," The Technology Press, Massachusetts Institute of Technology, 1957.
2. Knupp, C. H.; Shapiro, E.; Thorpe, R. A.; "The Z-Transform: A Method for Analysis of Sampled-Data Systems"; IBM Research Report RC-17, December 8, 1957.
3. Rugazzini, J. R.; and Zadeh, L. A.; "The Analysis of Sampled Data Systems"; Transactions of the AIEE, Part II, 1952.
4. Wadel, Louis B., "Analysis of Combined Sampled and Continuous-Data Systems on an Analog Computer," IRE Convention Record, PGAC, 1955.
5. Gimpel, D. J., "Sampled Data Systems," Control Engineering, February, 1957.
6. Chestnut, H.; Dabul, A.; Leiby, D.; "Analog Computer Study of Sampled Data Systems"; GE Report No. 57GL351, November, 1957.
7. Diamantides, N. D., "Multipurpose Electronic Switch for Analog Computer Simulation and Auto-Correlation Applications," IRE Transactions on Electronic Computers, 1956.
8. Klein, M. L.; Morgan, H. C.; Aronson, M. H.; Digital Techniques for Computation and Control; Instruments Publishing Co., Pittsburgh, Penna., 1958.
9. Favreau, R. R.; "Preliminary Summary of Diode and Relay Amplifier Circuits," PCC Report No. 55, Electronic Associates, Inc., Long Branch, New Jersey, April 15, 1956.
10. Truxal, J. G., Control System Synthesis, McGraw-Hill Book Company, Inc., 1955.

Palumbo and Sevian on Analog Study of an FM Discriminator

The fourth paper, "Analog Study of an FM Discriminator" by *O. J. Palumbo* and *E. A. Sevian* (both of RCA, Moorestown, N.J.), begins with the observation that the application of analog computers to the study of communication systems has been limited, presumably because the accuracy demanded for this type of design calculation has been regarded as beyond the scope of analogs. The paper then presents a new approach in employing the analog computer to design a frequency discriminator centered about a frequency of the order of 200 kilocycles per second, to be used in a receiver designed to accept a pulsed-carrier signal.

The paper then continues with a description of the problem and the analog instrumentation of it, chief feature of which are use of a perturbation technique (to justify assumptions of linearity) and a time-scale change of 10^5.

The large time-scale change required that amplifier drift be compensated, and a circuit to accomplish

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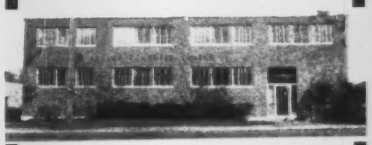

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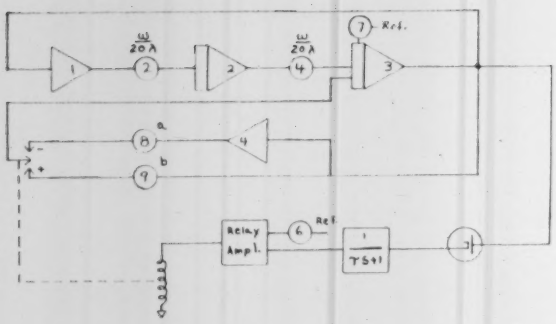

FIG. 3. AMPLIFIER-DRIFT compensation circuit.

this was shown and discussed (Fig. 3).

It is also necessary to simulate a four-pole Butterworth filter, a graphical method of locating the poles was given and the mechanization of the filter and discriminator were set forth.

In conclusion the authors state that the instrumentation of the frequency discriminator served as an accurate method of measuring frequencies on the analog computer, and can be used in other applications for such purposes.

Western Simulation Council and DDA Council Meeting of 6 March on Z Transforms

Seventy-seven representatives of at least 40 different organizations signed the register when the Western Simulation Council held its meeting at Lockheed Missiles and Space Division, Palo Alto, on March 6th.

Jack Sherman represented LMSD and introduced the speakers, first of whom was *Gene Franklin* (Stanford University). Gene spoke well on the subject of analysis of sampled data systems. The talk was essentially a short course on the use of the Z-transform, with particular attention to the meaning of the location of poles in the Z plane. Gene explained the subject so well that for a time your Ed. had the feeling that he too understood how to apply this useful transform—but the feeling passed!

The next speaker, *Rubin Boxer* (Servomechanisms, Inc.), demonstrated that he knew how to apply a useful tool when he used the Z-transform technique to analyze the error introduced when a continuous variable is represented by discrete samples, as for example when a digital computer is used to represent an analog computer or physical system in which the variables change in a continuous rather than a discrete manner.

The final speaker of the morning session, *Edwin Goldberg* (Space Technology Laboratories, Los Angeles 45, Calif.), gave Rubin tit* for tat by showing how an analog computer can be used to represent a digital computer. Essentially the difficulty was that to solve recursion equations as a digital computer does, the analog computer needs discrete past values of the variable of interest —i.e., the analog computer needs a memory. To supply it the boys at Space Technology Labs connected analog-to-digital, digital-to-analog converters (in this case their Addaverter) back-to-back and pulsed them with special equipment they had developed for the purpose in such a way that the information progressed down the line by discrete steps. Thus, at time t, the first digital-to-analog converter would have a voltage at its output equal to that of the variable at time $t - \tau$, the second d-a (not a-d) converter would have the value at $t - 2\tau$, etc.*

Ed's talk was followed by a quick tour of the LMSD computer facilities —quite impressive.**

After the tour practically all hands adjourned to Rickey's Studio Inn for lunch, and again LMSD furnished chartered bus service for those who wished it.*

Schart on DDA'S

After lunch, while the Western Simulation Council held informal group discussions, the DDA Council held a separate meeting at which General Electric presented a short movie and talk on their variable-increment drum computer, GEVIC, and *Bill Schart* (Convair-San Diego, Calif.) gave a tutorial talk on DDA's.

Bill's talk described the basic principles and mathematics of these "digital computers which solve problems like analogs" and suggested a way of building such a computer using a magnetic drum. The talk was based on "An Introduction to DDA's** which he presented at a DDA Council meeting in New York City on 15 July 1957, but Bill brought it up to date by reference to Max Palevsky's work at Packard-Bell on TRICE, the "real time DDA" which uses delay-lines instead of a magnetic drum.

The GEVIC was developed by GE as "a new concept in Airborne Digital Computers" but is expected to have more general application. It is a magnetic-drum incremental computer like the earlier DDA's, but because it can automatically vary the increment size to accommodate different rates of changes in variables, it can handle some problems in real time which fixed-increment computers cannot.

The parallel Western Simulation Council discussion groups in the meantime considered:

Simulation of Sampled Data Systems,
Analog Computer Equipment,
Maintenance Techniques,
Digital Differential Analyzers,
Digital-Analog Techniques,
Analog Simulation Techniques,
Physical Simulation, and
Accuracy and Checking of Solutions.

These informal discussion groups were *so* informal that though your Ed. got notes from *Hans Meissinger* (on Analog Computer Equipment),

*Not literally!

*Ed's colleague, *M. S. Shumate*, discussed this same technique in his paper "Simulation of Sampled Data Systems Using Analog-to-Digital Converters" presented at the 1959 Western Joint Computer Conference in San Francisco just the day before. Mike's paper will be published in the WJCC Proceedings.

**Unless you have seen Astro's!—Ed.

*They even said they would have treated all of us to a steak dinner, but didn't want to set such a precedent!

**Copies available from William J. Schart, Convair, San Diego, Calif.

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· *data processing division*

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Willard Uplinger (Physical Simulation), and *George Bekey* (Accuracy and Checking of Solutions) it is not possible to report the real value—i.e., the stimulating effect, of these exchanges of experiences and opinions.

Hans noted that *Joe Hussey* reported on the status of the Western Simulation Council's Multiplying Committee, which was roughly to the effect that it suffered from lack of leadership, (which was at least partially the result of the illness of one of the Simulation Council's most dynamic leaders, Norm Irvine). All agreed that the effort should be rejuvenated and some suggestions were made, for referral to the Western SC's steering committee.

In addition, function generators, including TRIDIG (Ardestra)* and standard tests (also to be referred to the Steering Committee) were considered.

Willard Uplinger reported on work at Pacific Missile Range** on their Bendix Three-Axis Flight Simulator, and described the simulator in some detail.

Stanford Research Institute is working on a "mobility gauge" to measure the mechanical impedance of structures (force/velocity) which, it was agreed, should be connected into the computer.

Boeing is using analog computers on the production line for Bomarc checkout. They have minimized downtime to less than 1% by third-shift preventive maintenance and by leaving the equipment on all the time.

In contrast to Boeing, Hughes Aircraft reports better results from "fix when broke" maintenance.

George Bekey reports that his group discussed the validity of automatic checkout equipment; factors that influence accuracy (specifically the bandwidth of servos, function generation, output devices and human errors—i.e., "static between the headsets"). This was followed by a more detailed consideration of methods of systems checking the formulation of problems.

After the discussion sessions the group was transported to the Lockheed computer installation at Sunnyvale where they had their pictures taken. Thus ended a meeting both pleasant and enlightening.

*Whatever that is.—Ed.

**NAMTC. Pt. Mugu to us oldtimers.—Ed.

Information With Some Organizational Theory

The original Simulation Council (now the Western Simulation Council) was formed in 1952 by those of us who were concerned with the development of simulation equipment and techniques, to discuss our mutual problems while they were still problems. It was our intent that when solutions were found and written up, the papers should be presented before one of the more formal existing technical societies. Some of us still think so. We also think there are too many technical meetings concerned with computers and simulation. Hence our past efforts to cooperate with the National Simulation Conference in Texas, the Automation Exposition in New York, and the Joint Computer Conferences on both coasts. We hoped thus to create a forum for the presentation of formal Simulation Council papers without increasing the number of national computer meetings by having one of our own.

At the same time, since members would be given an outlet for their more formal papers, we hoped that we could keep the regular Simulation Council meetings informal. This effort has been only partially successful.

The original idea of the *Newsletter* was to let those who could not attend the Simulation Council discussions know who was working on what problems and, to the extent possible, the line of attack and progress. It was never the intention of the *Newsletter* to tell anyone how to solve their problems* but only to bring the problems into the open and let those concerned know where more information might be available.

In spite of our desire to keep at least one eye on our original objectives, the growth of the field, the advances in the state of the art and, perhaps most of all, the large numbers attending Simulation Council meetings, have resulted in greater formality. Some like this—it makes them feel important. But the formal papers presented often confuse the many, while enlightening a few. And they certainly make Simulation Council meetings more like just that many more computer meetings. This change has had its effect on the *Newsletter*. Instead of an easy-to-read narrative account of Simulation Council meetings telling about people and what they are up to, the Council secretaries all too often send your Ed. a stack of formal papers which were presented. And I'm complaining? Yes! Not because I don't think these papers, many of them excellent and most all of them worth while, have their place, but because *I don't think their place is this Newsletter.* I can't do them justice.

Perhaps the foregoing will explain why your *Newsletter* might sometimes seem to devote time and space to half-baked ideas and pass over real contributions to the art with a casual mention. It is because your Ed. is trying to keep the *Newsletter* a place for the presentation of ideas (that might need a little more cooking) to readers (who might have a back burner to spare.) Sometimes I goof!

*And we haven't!

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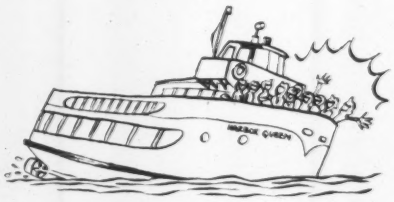

Questions: 1. Was there a bar on board?

2. Was it located fore or aft?

Hint: This was the 1959 WJCC "Harbor Tour"**

*i.e., the winner will find it *all* expensive.

**Good going, Bob Douthitt!

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by C. S. Beard. New "one-book" reference on control valves . . . covers flow characteristics; mechanical features; valve capacity; sizing; body types; positioners; actuators, including d-c, electrohydraulic and gas hydraulic actuators. Numerous tables and illustrations. Paperbound, 236 pages, 1957. **$2.00**

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by H. C. Roberts . . . describes gaging methods based on variations of capacitance, inductance, resistance, as well as photoelectric piezoelectric, thermoelectric, acoustic, and other methods . . . covers principles of bridge and potentiometer circuits, plus required and available equipment. Second edition, cloth, 368 pages, 1951. **$2.00**

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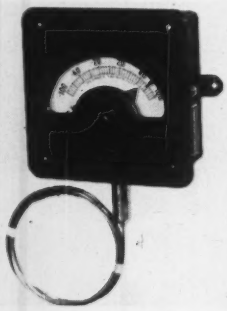

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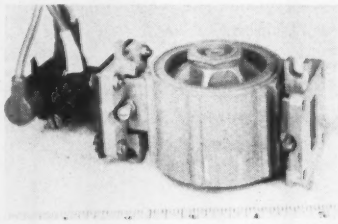
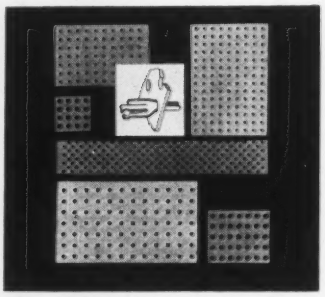


For more information circle **174** on inquiry card.

PRE-PUNCHED TERMINAL BOARDS

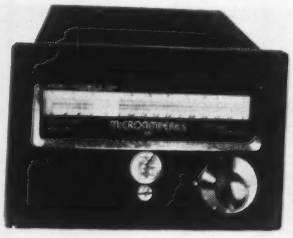
New Vectorbord series of prepunched terminal boards for use in breadboarding and permanent installations is available in different patterns with 0.062" and 0.093" holes, in XXXP Phenolic, G-7 glass silicone, G-10 glass epoxy, and paper epoxy.—*Vector Electronic Co., 1100 Flower St., Glendale 1, Calif.*



For more information circle **175** on inquiry card.

ELECTRIC INDICATORS

New 700-Series of ultra-precision Current and Voltage Panel Meters is available in up to 23 ranges in one

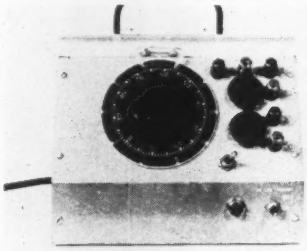


model, with full-scale sensitivities to 0.20 μa. Featuring extremely low resistance (2mv drop on the one μa range) and the ability to withstand overload surges of 100,000%, they permit measurement of transistor parameters directly without amplification.—*Greibach Instruments Corp., 315 North Ave., New Rochelle, N. Y.*

For more information circle **176** on inquiry card.

POTENTIOMETER TESTER

New Model SR-1 Servo Ratiometer, a precision voltage divider, can inspect operation of any component or

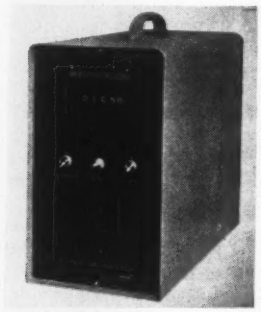


system whose output can be expressed as the ratio of an output voltage to an exciting voltage. Over-all accuracy of the unit (including linearity, hysteresis, and repeatability error) is ±0.001 voltage ratio. Direct measurement can be made, based on independent, zero-based, terminal-based, or index-point conformity or linearity.—Performance specs and other pertinent information are contained in Leaflet GMG-113.—*G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena, Calif.*

For more information circle **177** on inquiry card.

DIGITAL INDICATOR

New Model 170 Portable Digital Indicator and Force Calibrator, a self-contained continuously automatically



balanced digital servo indicator that uses no batteries or standardization, has a built-in check circuit as standard equipment. Furnished as a system, the instrument is characterized and calibrated with transducers to yield ultimate system capability.—*Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.*

For more information circle **178** on inquiry card.

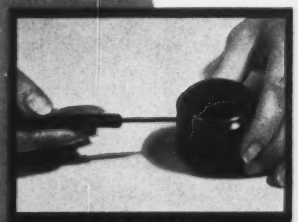
Magnet Calibration

TRANSISTORIZED
DIRECT READING
Gaussmeter
provides nine full-scale ranges

MODEL 1295A

RANGES (Gauss)		
0-100	0-1000	0-10,000
0-200	0-2000	0-20,000
0-500	0-5000	0-20,000 plus

This stable, all transistorized Gaussmeter operates on the Hall Principle and provides a conservative accuracy of ±3% over-all ranges. Accuracy can be increased to ±1% at any point between 500 and 20,000 gausses by use of special probe reference magnets. Response is flat when measuring magnetic fields from DC up to 120 cps. Correction curves are supplied for measurement of fields up to 400 cps.



TYPICAL REFERENCE MAGNET

The Model 1295A Gaussmeter operates from 115-volt, 50-400 cycle power line. Internal switching arrangement and battery holders are also provided for self-contained battery operation. Compartment in back of aluminum case provides storage for probe, reference magnet and power cord. Over-all size is 11 x 7 x 12. Weighs 12 lbs. Net price $420. complete.

Probe Reference Magnets

Unit is supplied with a 1000-gauss ±¾% probe reference magnet and one standard probe. Nominal probe thickness is 0.025". An ultra-thin probe, measuring 0.007" is available on special order. Sensitive element area of probes is approximately 0.017 square inches.

Prices are f.o.b. Boonton, N.J. & subject to change without notice.

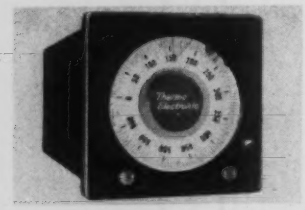
SEND FOR TECH. DATA
For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

For more information circle **82** on inquiry card.

SIGNALING CONTROLLER

New Signaling Controller, providing two-position control action, can be used with any transducer generating

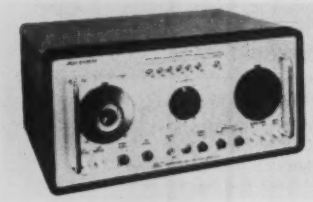


a d-c signal, such as thermocouples, tachometer generators, load cells, etc. It is sensitive enough to react to a change of but one μv.—*Thermo Electric Co., Inc., 109 Fifth St., Saddle Brook, N. J.*

For more information circle **179** on inquiry card.

SWEEP GENERATORS

New line of high-percision Sweep Generators features new cabinet designs, improved circuitry, exceptional



flatness, high output, and low leakage in Models H-3, H-D, L-D and S-D.—*Telonic Industries Inc., 773 Broadway, Laguna Beach, Calif.*

For more information circle **180** on inquiry card.

PRESSURE-RATIO COMPUTER

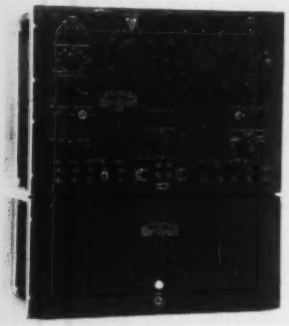
New pneumatic Pressure-Ratio Computer, Model PR-0, measuring compressor inlet and outlet pressures

(while simultaneously calculating the ratio of the two) features wide range, flexibility, accuracy and pneumatic signal transmission. It indicates pressure-ratio on an integral scale and generates a pneumatic signal proportional to pressure-ratio for use in a control system.—*Hagan Chemicals & Controls, Inc., Controls Div., Box 1346, Pittsburgh 30, Pa.*

For more information circle **181** on inquiry card.

PULSE GENERATOR

New Type 1391-B Pulse, Sweep, and Time-Delay Generator generates push-pull pulses, linear sweep volt-

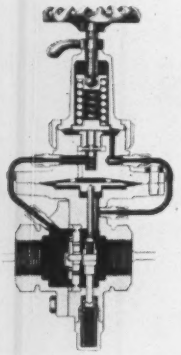


ages, time delays, and delayed trigger pulses which can be used independently to delay the initiation time of the sweep and main pulse relative to the input driving signal. Pulse duration is 0.025 μsec to 1.1 sec between half amplitude points, with repetition rates up to 300 kc. The time delay range is from 1.0 μsec to 1.1 sec and has a maximum PRF of 400 kc. Sweep duration range is 3 μsec to 0.12 sec, and the maximum repetition rate for 3 μsec sweep is 250 kc.—16-page issue of the "Experimenter," Vol. 33/No. 2 contains subject article by R. W. Frank.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **182** on inquiry card.

PRESSURE REGULATORS

New, redesigned ½" to 2"-size Piloted Pressure Regulators features sliding gate and plate seats, and new



external sensing tubes, Teflon pilot seat, handwheel and "thumlock" and ball-bearing adjustment. Suitable for pressures to 250 psi wsp and temperatures to 450°F. Available in ½" to 2" sizes from stock in bronze, cast iron and ductile iron with screwed ends.—2-page SRB 16-59 and 4-page bulletin J-1160 give details.—*OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio.*

For more information circle **183** on inquiry card.

OKOFLEX
distributors

California

E. Danielson
The Okonite Company
427 West 5th Street
Los Angeles 13

J. B. Caldwell
The Okonite Company
701 Phelps Street
San Francisco 24

Canada

Robert Muddiman Co., Ltd.
739 Mountain Street
Montreal

Robert Muddiman Co., Ltd.
58 St. Clair Ave., E.
Toronto

Florida

George F. Bohman
1239 Newcastle Drive
Orlando

Georgia

James T. Heagarty & Co.
560 W. Oglethorpe Ave.
Savannah

Illinois

Instruments Associates
7943 S. Exchange Ave.
Chicago 17

Massachusetts

Benson-Funk, Inc.
P. O. Box 31
Newton Lower Falls 62

Missouri

Fred Zopff
8030 Manchester Road
St. Louis 17

New Jersey

Fluid Controls Co.
of New York, Inc.
646 Anderson Ave.
Cliffside Park

Oklahoma

Ben McKalip Co.
4176 E. Admiral Place
Tulsa

Pennsylvania

Arobone and Cline
33rd & Arch Streets
Philadelphia 4

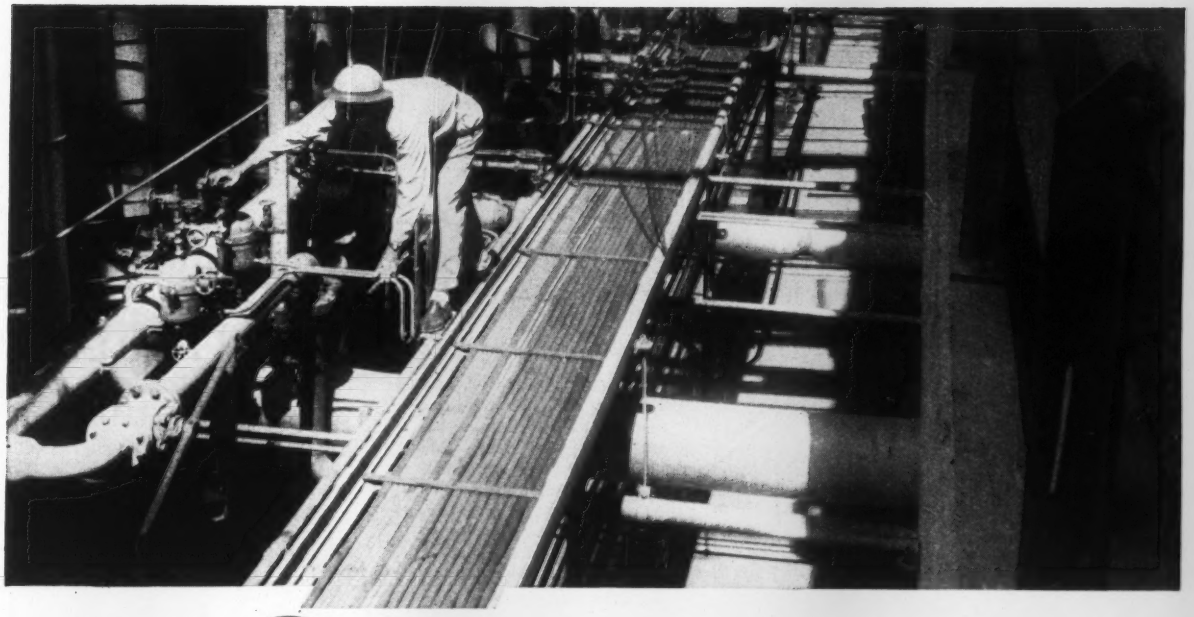
Tennessee

All-South Sales & Engineering Co.
P. O. Box 5271
Memphis 16

Texas

J. K. Moore Company
3115 Leeland Avenue
Houston 3

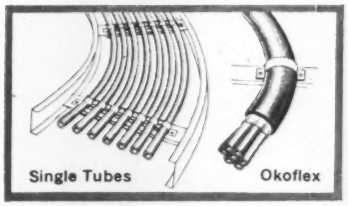
For more information circle **83** on inquiry card.



New 3-WAY approach reduces cost of instrument tubing

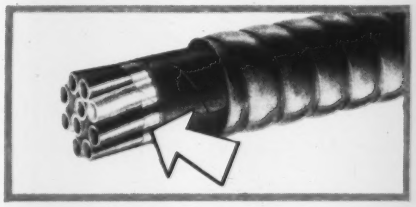
New Okoflex* armored instrument tubing costs less to install than single tubes, yet gives vastly increased resistance to corrosion and mechanical abuse. In addition, **Okoflex costs no more than ordinary multiple instrument tubing.**

Here is the Okoflex three-way approach to reducing your instrument tubing costs:



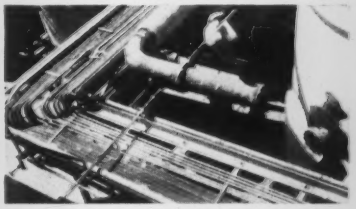
1. Lower installation cost

An Okoflex assembly, consisting of several tubes, takes about the same time to install as a single tube. Existing structures can be used for support, and standard fittings are used for attachment. Armored Okoflex can be "fished" quickly through inaccessible or hazardous locations without fear of tube damage. In addition, Okoflex can be taken down and used over and over again. It is completely salvageable.



2. More durability

Only Okoflex has a Mylar® tape over its core of tubes. This DuPont polyester film provides *extra* protection against both environmental corrosion and galvanic action between the tubes and a metallic covering. One of several Okoflex coverings—each designed for a specific situation—protects the tubes from both physical damage and corrosion. All tubes are tested at not less than 150 psi prior to cabling, and every foot of an Okoflex corrosion-resistant sheath is electrically tested at 4,000 volts to insure that no perforations are present.



3. Tube flattening eliminated

Okoflex cabled tubes—spiraled like strands of rope—can be bent on a small radius without distortion or flattening. Circular in shape, Okoflex' smooth exterior permits easy water and vapor-tight connections with standard fittings. Stresses are distributed evenly to give excellent resistance to mechanical abuse. And on delivery, you'll find that *every* tube is usable . . . none bent or damaged.

* Okoflex is licensed under U.S. Patent No. 2,578,280

For engineering information and prices, contact the Okoflex distributor nearest you. He is listed on the opposite page.

THE OKONITE COMPANY
Subsidiary of Kennecott Copper Corporation
Passaic, New Jersey

OKOFLEX . . . the low cost way to install instrument tubing

6902

For more information circle **83** on inquiry card.

RELIABILITY... THE SOLUTION TO YOUR ELECTRONIC COMPONENT PROBLEMS

Designing reliability into electronic components and instrumentation is Borg Equipment Division's business. Borg's reliable engineering, research and production facilities are at your service for commercial or military projects. Bring your component reliability problems to Borg. You'll enjoy working with our cooperative, creative engineering staff. The result will be a sound, practical and reliable solution at a considerable saving of time and money. Here are just a few of the products manufactured by Borg . . .

- FREQUENCY STANDARDS
- AIRCRAFT INSTRUMENTS
- POTENTIOMETERS
- MULTI-TURN COUNTING DIALS
- FRACTIONAL H. P. MOTORS
- SPECIAL DESIGNS

WRITE FOR COMPLETE ENGINEERING DATA

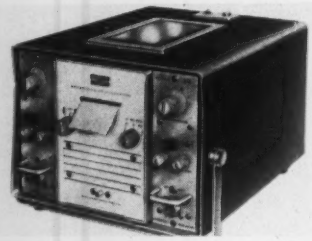
BORG *Built by Borg*

BORG EQUIPMENT DIVISION
AMPHENOL-BORG ELECTRONICS CORPORATION
JANESVILLE, WISCONSIN

For more information circle **84** on inquiry card.

RECTILINEAR RECORDER

New Meterite, Model BSA 200, the first completely versatile and portable 2-channel Rectilinear Recording

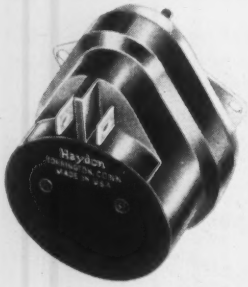


System, can record practically any phenomena between dc and 200 cps by simply inserting interchangeable plug-in pre-amps that are compatible with the signal source to be recorded. Interchangeable low, medium, and high-gain dc-, ac-, chopper-, and carrier-pre-amps are available.—*Massa Div., of Cohu Electronics, Inc., 5 Fottler Rd., Hingham, Mass.*

For more information circle **184** on inquiry card.

LOW-COST TIMING MOTOR

New low-cost moisture-proof Timing Motor, MP-11, for chart drives, timing devices, etc., is a heavy-duty,

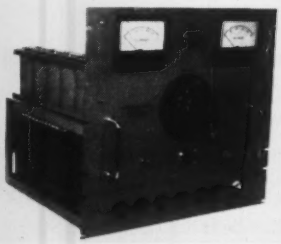


permanent synchronous type with a guaranteed torque of 30 in-oz at 1 rpm. Synchronization is maintained over a range of 103 to 132 vac. Standard shaft speeds are available between 1/60 rpm and 60 rpm.—*Haydon Div., General Time Corp., 245 East Elm St., Torrington, Conn.*

For more information circle **185** on inquiry card.

D-C POWER SUPPLIES

New TRM series, an integrated group of fourteen d-c power supplies offering a broad range of voltages



MINIATURE MANIFOLDS for Multi-Purpose CONTROL

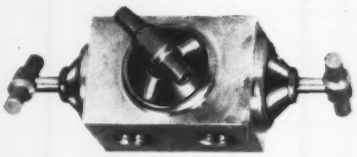


Photo ½ actual size

"DEMI" M2 SERIES

All models of the standard Dahl "Demi" M2 series of three-valve manifolds are readily adaptable to clean liquid, gas and vapor applications. The size of these manifolds makes them especially suitable for pilot plant, aircraft and marine applications, flow control and automation. They are miniature in size, yet their patented form for bubble-tight shutoff makes them comparable to much larger valves in performance.
These manifolds consist of two block valves and one bypass valve in place of 3 separate valves . . . they eliminate two tees, four nipples and eight threaded connections. Models of the "Demi" M2 series come in a variety of barstock materials and may be ordered with special features such as: bolted bonnets, swaged-in TEFLON seats, toggle actuators, etc.

PRESSURE RATING Metal Body & Diaphragm Neoprene Diaphragm	 750 psi at 450°F 100 psi at 180°F
MAXIMUM Cv	0.4
CONNECTIONS	1/16", 1/8", 1/4" N.P.T.

Send for the "DEMI" Catalog D-1 and other technical data on Dahl pneumatic and hydraulic valves.

GEORGE W. DAHL COMPANY, INC.
86 TUPELO STREET, BRISTOL, RHODE ISLAND

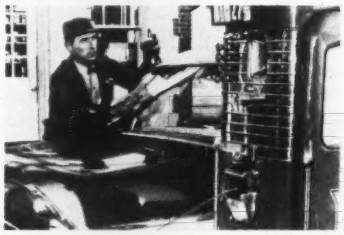
For more information circle **85** on inquiry card.

centered about four popular industrial values in the 5-to-160-v region for loads of up to 120 a, features a unique combination of magnetic-amplifier regulation, a transistorized driver amplifier with high-speed response, and precise regulation normally found only in light-duty laboratory supplies. A set of modular auxiliary capacitor banks permits tailoring the transient response of the power supply to the needs of the application. Ripple is less than 1% rms in all models.—*NJE Corp.*, 345 *Carnegie Ave., Kenilworth, N. J.*

For more information circle **186** on inquiry card.

EVEN-DOLLAR GASOLINE COUNTER

New "preset" counter makes "push-button" delivery of one, two, three, four, or five dollars of gasoline to



service station customers possible. Together with the fully automatic shut-off nozzle, the device provides for automatic delivery of "even-dollar" amounts as well as full tanks of fuel to the customer.—*Veeder-Root Inc.*, 28 *Sargeant St., Hartford 2, Conn.*

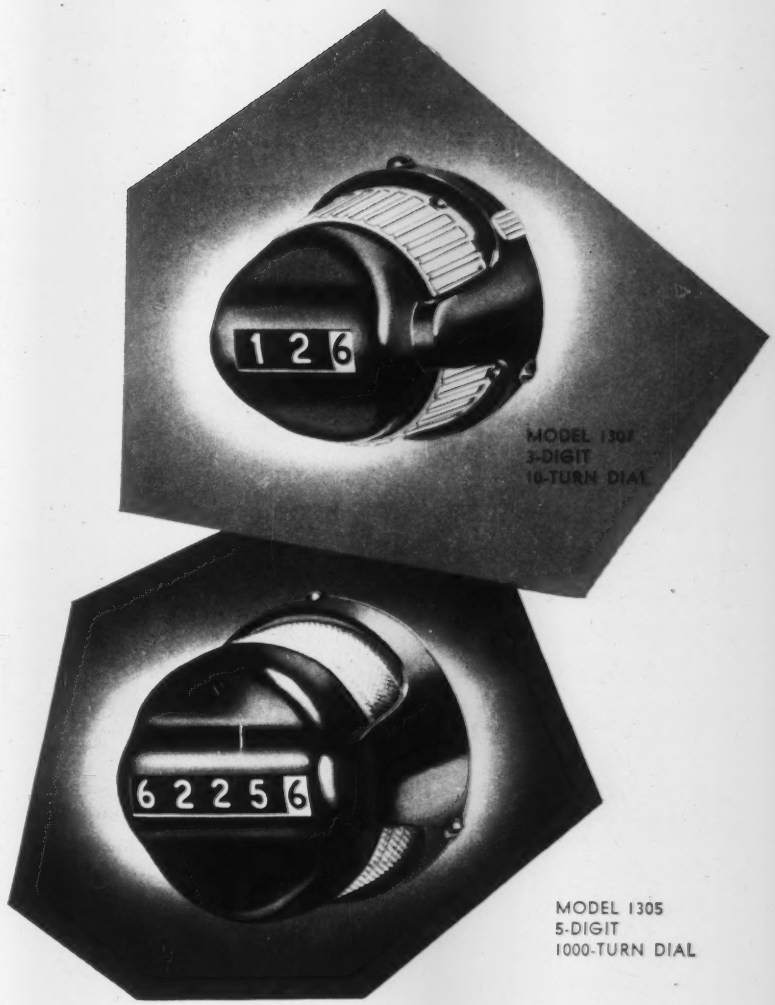
For more information circle **187** on inquiry card.

NOISE SURVEY METER

New palm-sized Noise Survey Meter to monitor and measure noise hazards is designed for rapid, multi-

location measurement of sound levels to establish "noise-contour maps" in large industrial plants. Energized by a small, long-life mercury battery, sound pressure levels can be read quickly in the range of 74 to 140 decibels. Two models are being offered: (1) the Industrial Hygiene Model, which has frequency response characteristics based on hearing damage criteria, and (2) a model for noise reduction studies and acoustical engineering surveys which has a "flat" response.—*Mine Safety Appliances Co.*, 210 *N. Braddock St., Pittsburgh 8, Pa.*

For more information circle **188** on inquiry card.



THERE'S YOUR READING...

JOT IT DOWN!

Standing on your head to get accurate readings from out-dated counting dials? Solve this human engineering problem with Borg Multi-Turn Direct-Reading Microdials. Glance at the dial . . . there's your reading . . . jot it down. No chance for error in subsequent readings and settings now because you're first reading was accurate!

Borg Direct-Reading Microdials are available in 3-digit 10-turn models, 4-digit 100-turn models and 5-digit 1,000-turn models. Also available . . Borg Concentric Scale Microdials for multi-turn devices of 10 turns or less. More information? Lots! Write for it today.

ASK FOR CATALOG BED-A90

BORG EQUIPMENT DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION

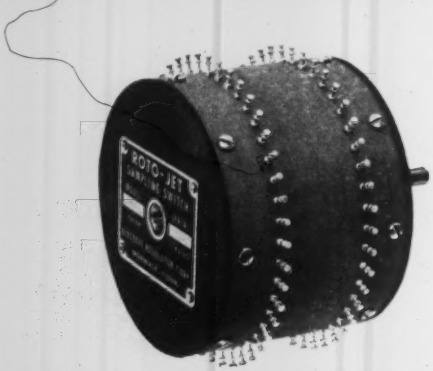
JANESVILLE, WISCONSIN

BORG

MICROPOTS
MICRODIALS
MOTORS

For more information circle **86** on inquiry card.

HIGH SPEED SWITCHING



NEW ROTO-JET®

SEQUENTIAL SAMPLING SWITCH
MAKES MORE THAN 3,600 CLOSURES/SECOND

No commutator to cause noise and wear! Contacts are closed by a **rotating jet of air!** New self-cleaning ROTO-JET represents the most outstanding development in long life, high speed switching in many years.

At low power levels, signals of 1, 2, and 3 millivolts can be directly transmitted free of measurable noise. Flexible, versatile, **module contact** design enable ROTO-JET to be built with any number of contacts required for a specific application.

Here is the long awaited innovation in high speed sampling and switching where a large number of voltage-generating elements must be connected successively to a single load. ROTO-JET is the perfect solution for **directly** commutating signals from thermocouples; strain gages; light-sensitive devices; and similar low level, high impedance elements employed in computers, telemetering systems, and complex process control. For full details, write for new Bulletin No. 8.030.

Just compare!

ANY SAMPLING SPEED—Sampling or switching speeds up to 40 revolutions per second.

SPLIT-SECOND CONTACT—Closing time less than 60 microseconds; opening time less than 80 microseconds.

2-POLE SWITCHING—Easily supplied to any phase angle.

POSITION INSENSITIVE—Mounts in any position; no effect on precision operation or performance.

NO MAINTENANCE—Wiperless contact design. Routine cleaning of contacts accomplished while switch is operating simply by increasing air pressure for several seconds.

ROTO-JET®

ELECTRIC REGULATOR CORPORATION
Norwalk, Connecticut

Manufacturers of REGOHM® Regulators, MAGOHM® Magnetic Amplifiers, and GOVOHM® Diesel Generator Governors.

For more information circle **87** on inquiry card.

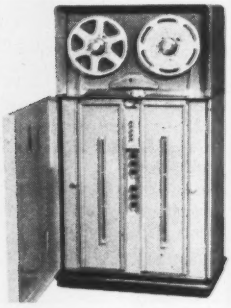
BI-FLUID PRESSURE TESTER

New Type 472 Bi-Fluid Dead-Weight Tester overcomes present difficulties encountered in testing oxygen equipment, etc. by using two separate fluid chambers. While pure water is used as the hydraulic fluid entering the gage or unit under test, various lubricating oils (including fluorolubes) can be used in the piston-cylinder chamber. A two-piston hydraulic hand pump enables the operator to create 10,000 psi quickly with only 17 psi hand pressure. Tester is guaranteed to be accurate within 0.1%. Available capacities are from 200 to 10,000 psig.—*Amthor Testing Instrument Co., Inc., 45-53 Van Sinderen Ave., Brooklyn 7, N. Y.*

For more information circle **189** on inquiry card.

HIGH-SPEED TAPE READER

New TR7 fully-transistorized Tape Reader, is a self-contained free-standing unit suitable for reading 5-, 7-, or

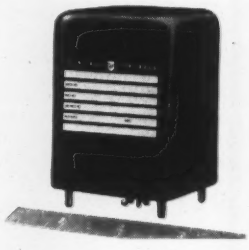


8-level tape at any speed up to 1000 characters/sec. A fast rewind gives less than 30 sec rewind time for 1200 ft of tape. Operating under either computer or manual control, reading character by character at high speed, it features a built-in checking facility.—*Ferranti Electric Inc., Electronics Div., 95 Madison Ave., Hempstead, L. I., N. Y.*

For more information circle **190** on inquiry card.

SINE WAVE OSCILLATOR

New transistorized Sine Wave Oscillator features unusual voltage stability over a temperature range from

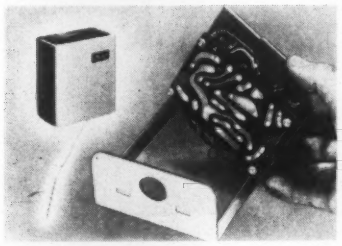


—55°C to 105°C; harmonic distortion under 1%; variation in output voltage amplitude under 0.2% for ±10% variation of input voltage; frequency stability of ±0.25%; voltage regulation of ±0.5%. Nominal voltage output is 3 v; nominal power output approximately 30 mw; output impedance is less than 30 ohms at output level of 3 v rms; power input is 2.5 w. Frequencies can be factory set from 20 cps to 50 Kc.—*General Controls Co., Electronics Controls Div., 801 Allen Ave., Glendale 1, Calif.*

For more information circle **191** on inquiry card.

THERMISTOR CONTROLLER

New Temperature Controller, Model 535, using thermistor sensing probes feeding into a transistor am-



plifier, cover a range of 0 to 600°F. Connections between sensing elements and controller can be uncompensated standard electric wiring.—*Fenwal Incorporated, Pleasant St., Ashland, Mass.*

For more information circle **192** on inquiry card.

HIGH-PRESSURE CONDUCTIVITY CELL

New high-temperature, high-pressure conductivity cell, suitable for temperatures up to 200°C (392°F)

NEW
HIGH-TEMPERATURE
HIGH-PRESSURE
CONDUCTIVITY
CELL

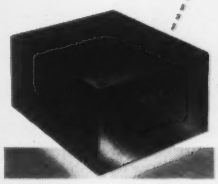
and pressures up to 300 psig, features a system for changing the cell constant approximately 10% above or below the nominal value.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **193** on inquiry card.

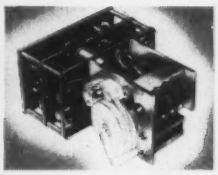
The **NEW *Series* BH100**

MILLI-V-METER*

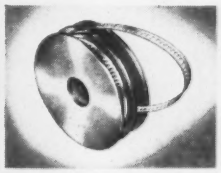
DIGITAL READOUT



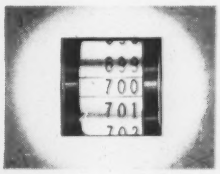
***SMALL SIZE** — This compact, transistorized, servo-driven instrument measures only 3 x 5 x 5¾".*



***ALL INCLUSIVE** — With Zener reference, power supply, amplifier, servo motor, 144" tape-slidewire.*



***TAPE-SLIDEWIRE** — Mounted on side-by-side spools, slidewire is embedded in edge of tape, punched for sprocket drive.*



***PRINTED READOUT**—Calibration printed on tape available to measure steady-state conditions or where input deviates more than 13%.*

ACCURACY 0.1%

THE INSTRUMENT with the TAPE-SLIDEWIRE

for FLOW · PRESSURE LEVEL · TEMPERATURE etc.

- Every scale division is a calibrated point.
- 100 calibrated points per foot of slidewire length.
- Slidewires up to 12 feet long.

LINEAR, PARABOLIC, LOGARITHMIC FUNCTIONS ARE DISPLAYED IN DIRECT DIGITAL RELATION

* TRADE MARK

Full information is available for the asking!

B & H INSTRUMENT CO., INC.

3479 West Vickery Blvd. • Fort Worth 7, Texas

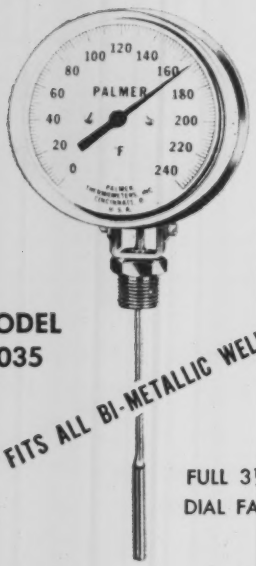
Sales-Engineering Offices: COMPTON, CAL., VALLEY STREAM, L. I., N. Y., DAYTON, OHIO
TORONTO, ONT. (George Kelk Ltd.), MITCHAM, SURREY, ENGLAND (Bryans Aeroquipment Ltd.)

For more information circle **88** on inquiry card.

Outstanding Accuracy

PALMER

Dial Thermometer



Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

PALMER

THERMOMETERS, INC.

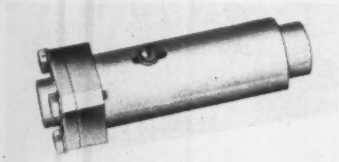
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

For more information circle **89** on inquiry card.

FLOW REGULATOR

New Flow Regulator for use in laboratories to ascertain exact flow requirements of hydraulic systems, is

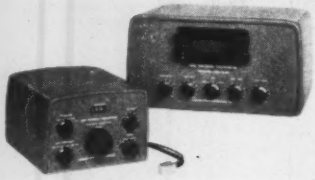


externally adjustable. Available in pressure ranges from 5 to 6000 psig. —*Vinson Eng. & Sales.*, 8044 *Woodley Ave., Van Nuys, Calif.*

For more information circle **194** on inquiry card.

NMR GAUSSMETER

New Model G-501 Precision Gaussmeter, for the determination of the magnetic field strength and homo-



geneity of stable or slowly changing magnetic fields between 300 and 20,000 gauss, is capable of a modulation sweep range of 0 to 20 gauss. —*Harvey-Wells Electronics, Inc., R&D Div.*, 5168 *Washington St., West Roxbury* 32, *Mass.*

For more information circle **195** on inquiry card.

LEVEL CONTROL PILOT

New Level-Matic Liquid Level Control Pilot features an adjustable proportional band which can be set while

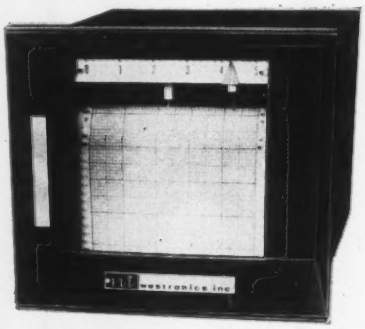
the liquid level system is in operation, without affecting the liquid level set point. Employing the differential-pressure sensing method, it is unaffected by surface turbulence.—Details are contained in 6-page Bulletin 583.—*Leslie Co.*, 122 *Delafield Ave., Lyndhurst, N. J.*

For more information circle **196** on inquiry card.

Where space is important...

westronics

DUAL PEN 5" RECORDING POTENTIOMETER



BOTH PENS RECORDING FULL SCALE

FEATURING

SMALL SIZE

- Only 25% the size of old line instruments
- Two recorders will mount in standard relay panel

VERSATILITY

- Minimum span—1 MV
- Plug in ranges, MV or TC
- Chart drives, synchronous and/or selsyn, with large selection of chart speeds
- Marker pens, L and/or R
- Limit switches
- Transmitting slidewires

Also available: One and two pen 11" recorders

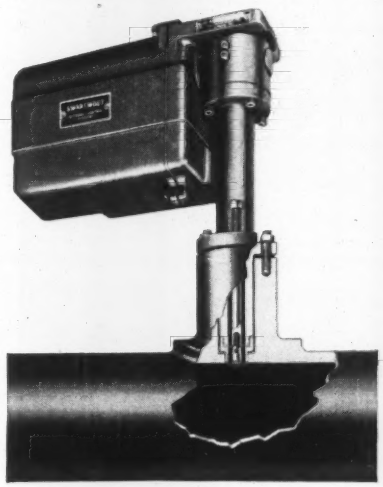
wi westronics® INCORPORATED

3605 McCART STREET • FORT WORTH, TEXAS

For more information circle **90** on inquiry card.

Great things are happening in AutroniC® Control

TOUGH PROBLEMS ARE NO PROBLEM



FOR THIS FOOLPROOF, FOUL-PROOF PRESSURE TRANSMITTER

Here is a primary sensing element for those tough jobs you'd like to forget. Mounted right on the process pipeline or tank, the Swartwout Flush Diaphragm Pressure Transmitter will effortlessly measure pressure or liquid level of polymers, slurries, asphalts, viscous fluids, molten metals and other difficult media. No stagnant pressure lines, no steam jacketing necessary . . . the stainless steel transmitter diaphragm fits flush with the inside of the vessel.

A friction-free linkage multiplies diaphragm motion and actuates the core of a differential transformer to produce a 0-0.5V AC signal for any Swartwout AutroniC indicator, recorder or controller. Sensitivity is better than 0.005%, reproducibility 0.1%, accuracy 1.0%.

The Flush Diaphragm Pressure Transmitter is just one unit in the constantly-growing AutroniC family of electronic instrumentation . . . a family that includes all necessary components for complete electronic control of any process parameter.

For details on the Flush Diaphragm Pressure Transmitter, request Bulletins A-713 and A-718. The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

SWARTWOUT

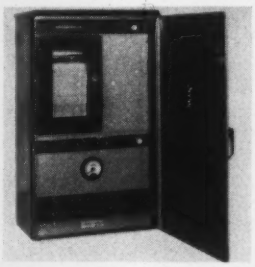
. . . world leader in electronic process instrumentation

S.A. 1959

For more information circle **91** on inquiry card.

AUTOMATIC WELL TESTER

New Automatic Well Tester, built in a modular construction, is capable of many functions such as sequence switching of wells from production to test manifold; identifying the well on test by a 2-digit Nixie tube bank,

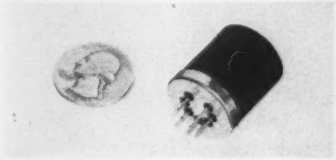


and simultaneously signalling the recording device of the well number and length of test time, etc. It has selection switches on each well, a fail-safe alarm circuit, a circuit permitting lease shut down, etc.—*General Controls Co., Industrial Systems Div., 801 Allen Ave., Glendale, Calif.*

For more information circle **197** on inquiry card.

SINUSOIDAL OSCILLATOR

New Model S-100 Silicon Transistor Sinusoidal Oscillator is an epoxy encapsulated unit designed to create a sine-wave signal source of miniature size and light weight, tempera-

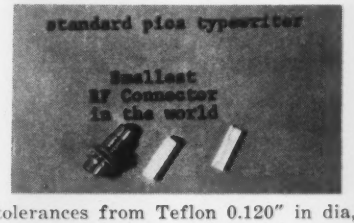


ture- and supply-stabilized. Frequency range is 25 cps to 100 kc. The oscillator is virtually immune to the effects of shock (500g, 11 msec), vibration (30g, zero to 2500 cps), and acceleration (700g).—*Solid State Electronics Co., 8158 Orion Ave., Van Nuys, Calif.*

For more information circle **198** on inquiry card.

R-F CONNECTOR

New super-miniaturized RF Cable (Amphenol's Series-27 Subminax) uses insulators machined to 0.001"



tolerances from Teflon 0.120" in dia, 0.420" long, with wall thicknesses of 0.016", retaining "fullsize" RF connector characteristics.—*Tri-Point Plastics, Inc., 175 I.U. Willets Rd., Albertson, L. I., N. Y.*

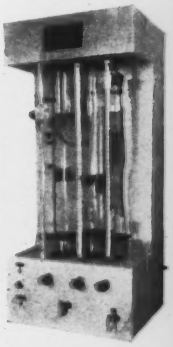
For more information circle **199** on inquiry card.

NEW LOW-COST PRECISION FLOW RATE CALIBRATOR

Now, with a low-cost Porter Volumetric Calibrator,* you can easily and accurately calibrate any fluid-flow device. Far simpler to use than other equipment presently available, this calibrator requires no vapor-pressure corrections or involved mathematical computations; its operation can be quickly mastered by even non-technical personnel.

The primary element of the unit is a free-floating piston which rides within a precision-bore glass tube. A unique "mercury-ring" seal gives the piston nimble responsiveness, yet prevents error-inducing leakage. Back-loading is extremely low, and is constant throughout the full range of piston travel.

Sizes from ½" to 5" with capacities from 25 cu. to 0.75 cu. ft. are available.



Portable Flow Rate Calibrator, Model No. 1050, is a complete, packaged test stand for ranges from 50 to 5000 cc/min. Unit has three precision-bore calibration chambers, a back-pressure indicator, gas temperature indicator, automatic overrange protection, automatic timer, and all necessary selector and dump valves.

*Pat. Pend.

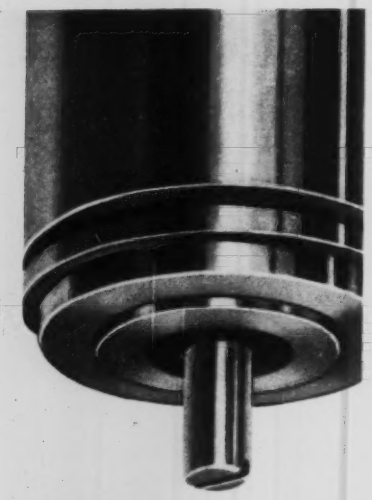
WRITE FOR DETAILED INFORMATION

BROOKS ROTAMETER COMPANY

659 J STREET, LANSDALE, PA.

S.A. 1936

For more information circle **92** on inquiry card.



new Bourns angular position transducers

Infinite Resolution/ Stable High Signal Level— AC & DC/10,000,000 cycle life—no sliding contacts/Vibration to ±35G; shock to 100G

New position transducer line designed for high accuracy servo-systems requiring infinite resolution—high sensitivity.

Differential transformer output signal for AC circuits. Available with integral demodulator for DC circuits.

Model	2200 (with Integral Demodulator)
Range	±45 (typical)
Input Voltage	26 v, 400 cps
Output Voltage	0.15 v per degree arc into 10K load
Linearity (20-0-20°)	±0.5%
Operating Temperature	−65 to +250 F
Frame Size	No. 15

Write for complete technical data

BOURNS Inc.
P.O. Box 2112FA, Riverside, Calif.
Field Engineering Offices:
L.I., New York, and Dallas, Texas

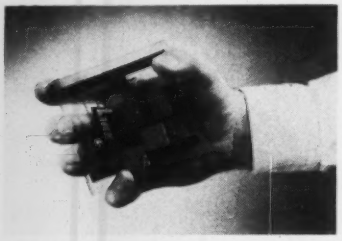
Pioneers in potentiometer transducers for position, pressure and acceleration. Exclusive manufacturers of Trimpot®, Trimit®

For more information circle **93** on inquiry card.

NEW INSTRUMENTS

FREIGHT CAR CONTROL

New Tracer system works in conjunction with a central control facility employing data processing equip-

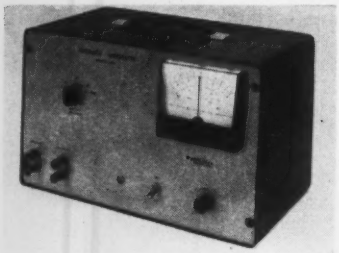


ment to provide continuous information on the location of every freight car on a railroad system. Control system consists of (1) a small Response Block, and (2) a magnetic Interrogator.—*Link Aviation, Inc., Binghamton, N. Y.*

For more information circle **200** on inquiry card.

IMPEDANCE COMPARATOR

New Model 506 Impedance Comparator is for fast and accurate tracking of potentiometers, temperature-



coefficient measurements, and the matching and sorting of components (such as resistors, capacitors, or inductors) which can be directly compared without adjustment. Four sensitivity ranges make possible the measurement of impedance differences from a small fraction of 1% to 20%. A phase-sensitive detector provides indication of the polarity of impedance difference as well as the magnitude.—*Dytronics, 78 Sunnyside Lane, P. O. Box 3676, Columbus 14, Ohio.*

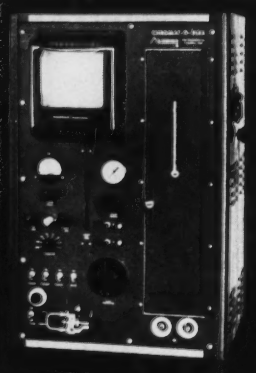
For more information circle **201** on inquiry card.

DIGITAL CLOCKS

New line of totally-transistorized Digital Clocks features a direct read-out, illuminated display and heavy-

duty output closures for data recorder entry, such as printers, electric typewriters, card punches, etc.

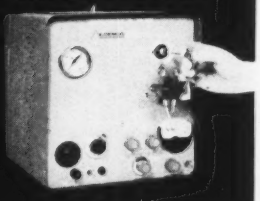
LOENCO
CHROMAT-O-FLEX



ACCURATE HIGH-SPEED CHROMATOGRAPH ANALYSIS
over a wide temperature range

model 1A features:
- Dual column switching with automatic backflush
- Multi-stage connection adaptors
- High performance detector for either filament or thermistor elements
- Ample oven space
- Precise electronic temperature control, proportional type
- Choice of sample introduction techniques
- Choice of high sensitivity recorders, integrators supplied if desired

NEW COMPACT
CHROMAT-O-FLEX
from $640



model 15 features:
- Measures 13¼" x 13¼" x 12". Wt. 35 lbs.
- Temperature range — from Ambient to 250°C. At small extra cost to 350°C.
- High sensitivity, shielded filament element detector
- Hot sample outlet fitting for sample collection
- Ample oven space for long columns
- Available with gas sample valve, column reverse valve, electronic proportional temperature controller

NOW SPEED UP ANALYSES WITH A LOENCO CHROMAT-O-FLEX
For Full Details, Contact

LOENCO
LOE ENGINEERING CO.
237 North Fair Oaks Ave. • Pasadena, California

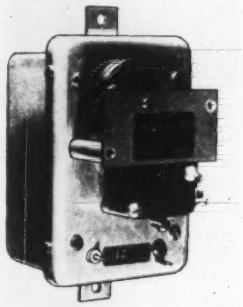
For more information circle **94** on inquiry card.

Clocks can be provided for operation on any frequency from 25 to 128 cps. Primary measurement of time is achieved by means of transistor flip-flop frequency division. Combinations with scanner and programming modules permit time control of complex system operations such as function change, channel selection, storage readout, indexing and recording. —*Electro Instruments, Inc.*, 3540 *Aero Court, San Diego* 11, *Calif.*

For more information circle **202** on inquiry card.

SEQUENCE TIMER

New miniature battery-operated Sequence Timer, Type AGS-C, uses a cam-operated miniature switch

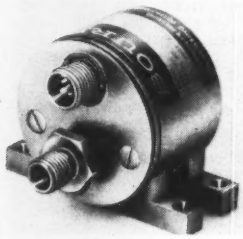


driven by an enclosed fhp motor with a speed regulation accurate to ±1% over a voltage drop of up to 50%. Requiring about 1/20 the current of an ordinary flashlight bulb, it is capable of switching circuits of up to 20 a.—*Brailsford & Co., Inc., Milton Point, Rye, N. Y.*

For more information circle **203** on inquiry card.

PRESSURE TRANSDUCER

New Model 717 Pressure Transducer employ a unique Ni-Span-C Bourdon tube movement that is re-



liable to 35g at 2000 cps vibration, for operating temperatures —65° to 200°F. Pressure ranges are from 0-400 to 0-5000 psia. Resistances are from 1 K to 10K ohms. Power rating is 1.5w at 165°F. Resolution is as low as 0.17%. The static-error band (including linearity, friction, resolution, hysteresis and repeatability) is ±0.9%.—10-page Specification 71717A contains details.—*Bourns Laboratories, Inc., P. O. Box* 2112, *Riverside, Calif.*

For more information circle **204** on inquiry card.

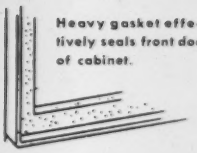
SAFE TO USE IN MANY EXPLOSIVE ATMOSPHERES!

SCAM® S-LINE ANNUNCIATOR SYSTEMS

INTERSTAGE PUMP FLOW 05-J-204 LOW
LOW LEVEL CLEAN SOLVENT TANK 02-E-453
ALARM D.C. FAILURE
RECYCLE PUMP FLOW 05-J-201-2A LOW
MAIN FAN FAILURE
CHLORINE HOUSE

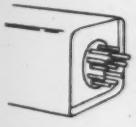
SCAM S-LINE ANNUNCIATORS can be used in a wide range of dangerous or contaminated atmospheres. Features include Failsafe Self-Policing, Momentary Lock-In Alarm, and NO or NC Field Signal Alarm Operation. Cabinet is easily sealed against dust and moisture. Units are versatile . . . available with Backlight or Bull's-Eye Cabinets, separate lamp cabinets and remote plug-in relay cabinets. Suitable for Class 1 Division 2 areas.

SEND FOR complete SCAM Literature. Give details of your requirements for SCAM Engineering Recommendations. No obligation.



Heavy gasket effectively seals front door of cabinet.

Air inlet can be located at sides, bottom or top for ease in connecting to air supply for purging.



Plug-In Relays are hermetically sealed to assure long life, trouble-free operation.

THE SCAM INSTRUMENT CORP.

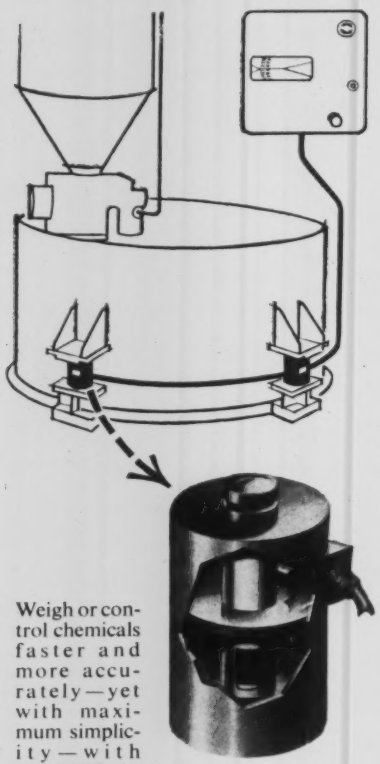
Dept. H • 1811 West Irving Park Road • Chicago 13, Illinois
GRaceland 7-7850

REPRESENTATIVES IN ALL PRINCIPAL CITIES • COMPLETE MONITORING SYSTEMS FOR INDUSTRY

For more information circle **95** on inquiry card.

MEASURING QUANTITY?

Then do it the modern way . . . with accurate, rugged, trouble-free SR-4® Load Cells



Weigh or control chemicals faster and more accurately—yet with maximum simplicity—with B-L-H SR-4® Load Cells. Installed as part of the tank support structure, no part of the measuring system comes in contact with the contents of the tank. Can be installed on tanks already in use. Output suitable for use with local or remote indicator, recorder or automatic dispensing control. Explosion-proof. Hermetically sealed—unaffected by dust, grease or moisture; long service life assured. Available in standard capacities of 50 through 200,000 lb., accuracies to ±0.10%.

For more information on load cells and complete batching systems, write Dept. 7-E and ask for Bulletins 4355 and 4510

FIRST in force measurement

SR-4 BALDWIN BLH LIMA-HAMILTON

BALDWIN·LIMA·HAMILTON

Electronics & Instrumentation Division
Waltham, Mass.
SR-4® Strain Gages • Transducers • Testing Machines

For more information circle **96** on inquiry card.

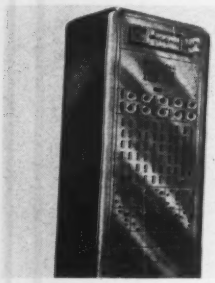
TURNTABLE DEGAUSSER

New semi-automatic Turntable Degausser, Model A-937, designed to accommodate all sizes of instrumentation tapes and magnetic films, features a predetermined 20-sec timed cycle. The pushbutton-controlled motor-driven turntable insures fast and complete bulk erasure and eliminates noise patterns which are generated by irregular rotational motion.—*Magnasync Mfg. Co., Ltd., 5546 Satsuma Ave., North Hollywood, Calif.*

For more information circle **205** on inquiry card.

MOVABLE ANALOG COMPUTER

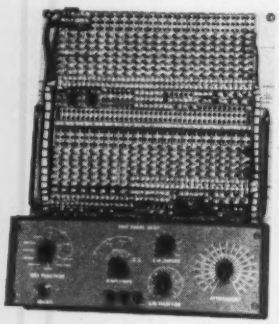
New self-contained Collegiate Model 500 Analog Computer, intended for use both in the college classroom and in the industrial laboratory, provides maximum flexibility as all components have their own front panels and are not permanently associated with each other. The low drift and noise of the chopper-stabilized operational amplifiers allows accurate real time simulation.—2-page bulletin gives details.—*Electro Precision Corp., Arkadelphia, Ark.*



For more information circle **206** on inquiry card.

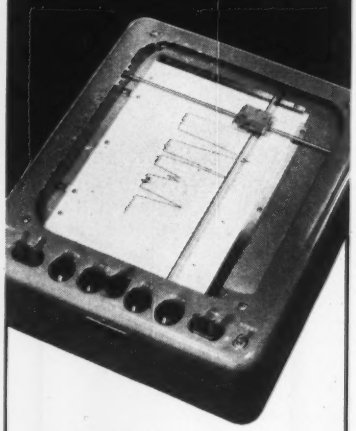
CHECK PANELS

New Preventive Maintenance Check Panels (PMC), Nos. 20.174 and 20.175, provide a rapid, convenient



HR-92 X-Y

RECORDER



- **Flat bed— Full Chart visibility**
- **Unitized Construction**
- **Critically damped response**
- **Simplified control panel**
- **Clip-on pen — Interchangeable for multicolor traces**
- **Standard 8½ x 11 paper**
- **Unconditionally guaranteed for one year.**

RUGGED "All Purpose" X-Y RECORDER

The HR-92 is a null-seeking servo-type plotter designed to draw curves in Cartesian coordinates on regular 8½ x 11 graph paper. It employs conventional chopper amplifiers, 2-phase motors and a potentiometer rebalance. Reference voltages are furnished by mercury cells. Control panel has zero set and continuously-variable attenuator for each axis. Separate standby and power switches are provided. Two axes are electrically and mechanically independent. By moving an internal jumper lead, a high impedance potentiometer input can be made available.

SPECIAL FEATURES:

- Amplifiers easily removed if servicing ever becomes necessary. Electrical connections all contained in two plugs for each amplifier.
- Each amplifier channel (including transformer power supply) independent of rest of system.

WRITE FOR:
New X-Y Recorder Circular #717-3 showing complete specifications and photographs.

houston instrument corporation

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For more information circle **97** on inquiry card.

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GAS ANALYSIS INSTRUMENTS

Continuous and Portable units

✓ **CHROMATOGRAPHIC ANALYZERS**

Complete systems for laboratory and process stream analysis — control.
CHROMA-CAT series extends utility of analysis, allows use of AIR as carrier gas.

✓ **ELECTRO-CONDUCTIVITY ANALYSIS**

Continuous measuring for PART PER MILLION toxic gases in work areas; impurity control in process streams. Applicable on any gases (or gas combustion products) which ionize in water.

✓ **COMBUSTIBLE GAS ANALYZERS**

REMOTE HEAD and multi-point systems for detection of combustible gases and vapors in work areas; Litho and coating oven atmosphere control; etc. Control of combustibles in inert gas streams.

✓ **THERMAL CONDUCTIVITY ANALYZERS**

MEASUREMENT of concentration of one gas component in a mixture of gases utilizing sensitive T/C filaments as the detector. Applicable for determination of: H_2 in $O_2 \cdot N_2$ mixtures; Argon in Air; Hydrogen purity; CO_2 in flue gas, etc.

Write for Descriptive Literature

DAVIS INSTRUMENTS
A Division of Davis Emergency Equipment Co., Inc.

80 Halleck St., Newark 4, N. J.

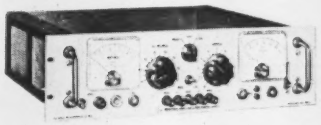
For more information circle **98** on inquiry card.

method of verifying the accuracy of the 16-31R and 16-131R Pace computer systems as well as smaller ones, and non-standard systems. They are permanently wired pre-patch panels with control and selector switches, allowing sequential testing of major computing elements by interrupting a problem for checking without disturbing the problem set-up. Bulletin PIR-858 gives details.—*Electronic Associates, Inc., Long Branch, N. J.*

For more information circle **207** on inquiry card.

SEMICON POWER SUPPLIES

New voltage-regulated Power Supplies can be used for constant current operation. Both wide- and narrow-

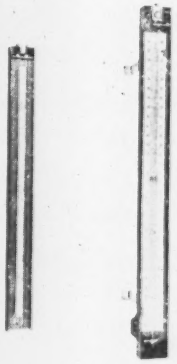


range models are available. Wide-range models cover voltage ratings of 0 to 7, 0 to 14, 0 to 32, 0 to 36, and 0 to 60; narrow-range models cover all popular battery voltages up to 60. Most models are available in current ratings of 0-2.5 a, 0-5 a, 0-7.5 a, 0-10 a, and 0 to 15 a.—4-page Bulletin 721 contains details.—*Electronic Measurements Co. of Red Bank, Eatontown, N. J.*

For more information circle **208** on inquiry card.

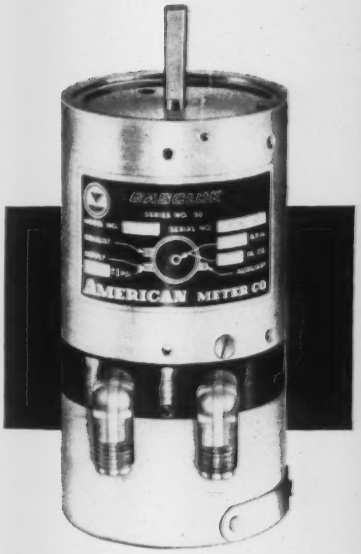
UNIVERSAL MANOMETERS

New Model U (left), the basic U-tube, and Model S (right), single-tube Manometers, both compatible



with every manometer fluid, use Pyrex, stainless steel, and non-deteriorating seals for wetted parts, which do not have to be changed when manometer fluids are changed. Model U is available in 8 sizes with scale heights from ± 3" to ± 25". Model S is standard in 13 scale heights ranging from 6" to 100".—*Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.*

For more information circle **209** on inquiry card.



AMERICAN®

GASCLOK POWER DRIVE

Completely self-contained gas or air-powered instrument driving and timing unit for long, trouble-free operation in remote locations. The GASCLOK delivers more than 20 times the torque of conventional spring-wound mechanisms. Continuous timing accuracy is unaffected by a ± 20% variation in supply pressure.

Inherently explosion proof and self-starting, the GASCLOK is ideal as original or replacement equipment for strip chart and conventional circular chart instruments. The timing mechanism is internally sealed to prevent corrosion, and all power unit parts exposed to gas are aluminum or stainless steel. Large area internal ports prevent clogging. Normal air or gas consumption 5 cfh . . . operating pressure 5 psi . . . rotation 2 rpm.

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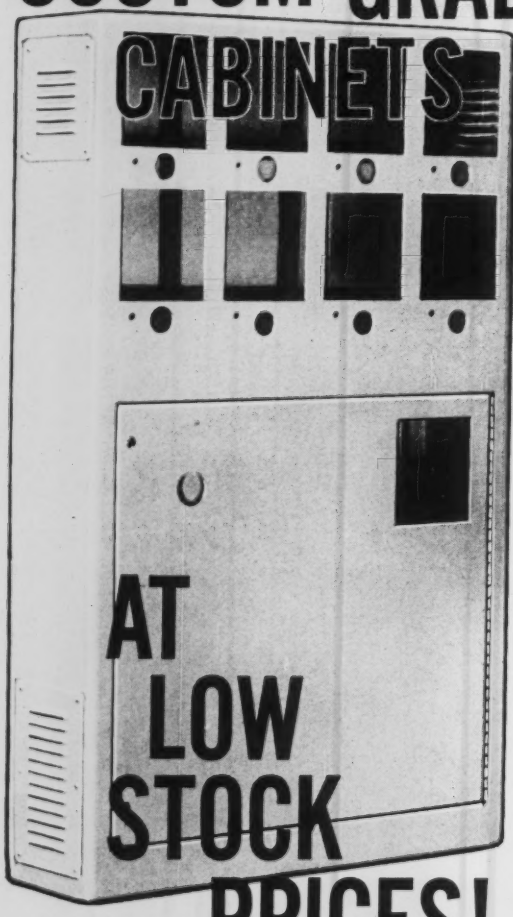

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* **fit your space exactly**
* **fit your equipment exactly**
* **protect costly, fragile instruments**

Now instrument panels, consoles, cabinets **don't have to be** EITHER **expensive** custom installations OR **cheap** stock items. Now New Brunswick brings you the benefits of EACH . . . custom-made cabinets at little more than stock prices.

What's more, GENCO heavy-gauge metal and rigid welded construction (far superior to light, bolted designs) provide assured protection for heavy or fragile equipment. And you specify the finish you want to match existing equipment.

Send coupon today for new, illustrated brochure on GENCO enclosures—the custom-grade cabinets you get at low stock prices.

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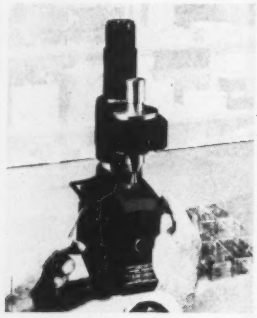
HIGH-SPEED MICROMETER

New direct-reading Digital Read-out Electronic Micrometer, capable of making 20 or more readings per min

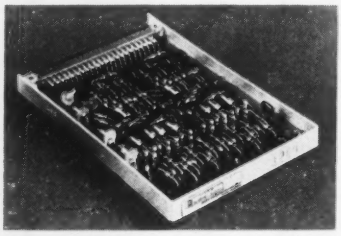


to accuracies of 20 millionths, is designed for production use especially with fragile or compressible materials. Measuring pressures required are from 0 to 20 grams.—*J. W. Dice Co., 16 Highwood Ave., Englewood, N. J.*

For more information circle **210** on inquiry card.

DUAL FLIP-FLOP

New Dual Flip-Flop, Model 1209, in the new line of 5-megacycle transistorized system building blocks

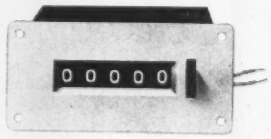


(containing two indentical flip-flops with built-in output amplifiers), uses saturated transistor digital circuits operating at any speed up to 5 Mcps. Components are used in making permanent or semi-permanent digital computer-type systems and in other data-handling applications.—*Digital Equipment Corp., Maynard, Mass.*

For more information circle **211** on inquiry card.

A-C ELECTRIC COUNTERS

New Model YE-Series Electric Counters are said to be the first of their type for use with ac for both



the operating and reset coils. With speeds up to 1500 counts/min they are offered in four models, for panel mounting and base mounting, with instant electric reset or push-button instant reset.—*Durant Mfg. Co., 1914 North Buffum St., Milwaukee 1, Wis.*

For more information circle **212** on inquiry card.

missile development

and test

INSTRUMENTATION

The growth of expanding missile and space age programs at Boeing offers unusually rewarding opportunities for original work in the fields of instrument design, evaluation, calibration and installation.

These are long-range assignments, primarily in advanced missile research and development areas related to measurement of surface temperatures, heat transfer coefficients, pressure, vibration, acceleration, strain and acoustics. Openings are available at virtually all professional levels.

Boeing is engaged in some of the nation's most exciting projects, including Minuteman, the Air Force's solid-propellant intercontinental ballistic missile and other advanced weapon system development programs.

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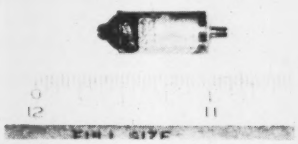
SUB-MIN PRESSURE SWITCH

New ¼-oz transistor-size Pressure Switch, designed for surge, leak, and variance detection, has operating

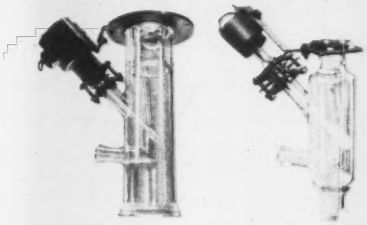


range from 1 to 500 psig; temperature range from −65°F to 250°F; setting limits from 1 to 100 psig; and stands vibration from 0 to 2000 cps at 10 g.—*Century Electronics & Instruments, Inc., Box 6216, Tulsa, Okla.*

For more information circle **213** on inquiry card.

REFLUX SPLITTER

New automatic Reflux Splitter, constructed of Pyrex and Teflon to provide full visibility of product flow

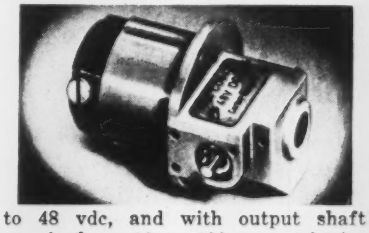


and corrosion resistance, has a Teflon gate as the only moving part. Electrically operated by solenoid and timer it eliminates valves as well as rotameters. Available in column and in-line designs. Pressure ranges are from 15 to 50 psig, with maximum temperature of 450°F. Will withstand thermal shock of 200°F.—*Chem Flow Corp., Dell Glen Ave., Lodi, N. J.*

For more information circle **214** on inquiry card.

GEARED FHP MOTOR

New reversible d-c Fractional Horsepower Motor, Model CO-843, available for inputs ranging from 6



to 48 vdc, and with output shaft speeds from 10 to 100 rpm (obtainable through built-in double-gear reduction), features a center-shaft bearing, located near the center of balance. The armature is carried on one end of the shaft, having no outboard bearing. The driving worm, at the other end of the shaft, has an additional bearing on its outboard end. Output torque (max.) is 50 in-oz.—*Carter Motor Co., 2707A W. George St., Chicago 18, Ill.*

For more information circle **215** on inquiry card.

NEW MINIATURE PRESSURE TRANSDUCER BY COLVIN

- Only One inch square — one inch long
- Withstands high vibration 35 G to 5000 CPS

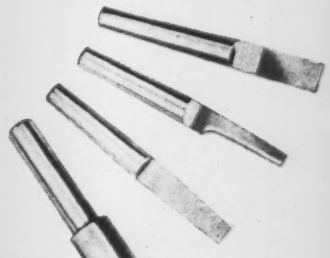
AVAILABLE IMMEDIATELY

COLVIN LABORATORIES, INC.
364 Glenwood Avenue East Orange N J

For more information circle **102** on inquiry card.

PREIS-PANTO *SINGLE-LIP ENGRAVING*

cutters

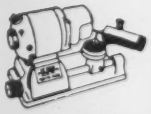


STRAIGHT AND TAPERED SHANK CUTTERS IN H.S. STEEL, TUNGSTEN CARBIDE, DIAMOND TIPPED AND DIAMOND DRAG MARKING..

are now available in improved design at new low prices. All single lip cutters are furnished unsharpened or sharpened to any shape or angle required.

Unsharpened cutters stocked for quick delivery.

See Preis first for complete line of quality engraving machines and accessories.



CUTTER GRINDER
for sharpening your engraving cutters

TRADE MARK PANTO

Write for complete details and prices. For immediate attention write directly to manufacturer below. Ask for nearest representative.

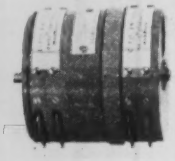
H. P. PREIS ENGRAVING MACHINE CO.

661 U. S. HIGHWAY 22, HILLSIDE, NEW JERSEY

For more information circle **103** on inquiry card.

ENCODER ASSEMBLY

New Geared Encoder Assembly, CG-701, capable of resolving shaft positions to 1 part in 10,000, uses

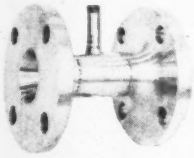


two shaft position encoders and a gear box. The encoder used on the input shaft provides 1,000 positions of the least significant digit per 360° rotation. Because the disc of this encoder is coupled directly to the input shaft, accuracy is that of the encoder used (±1 count). Input unit is geared 10:1 to a 10-position encoder. The low-speed encoder utilizes double-brush, lead-lag logic to eliminate ambiguities due to gear inaccuracy and backlash. Hence, the accuracy of the CG-701 is determined only by the accuracy of the encoder attached to the input shaft.—*Datex Corp.*, 1307 *So. Myrtle Ave., Monrovia, Calif.*

For more information circle **216** on inquiry card.

TURBINE TYPE FLOWMETER

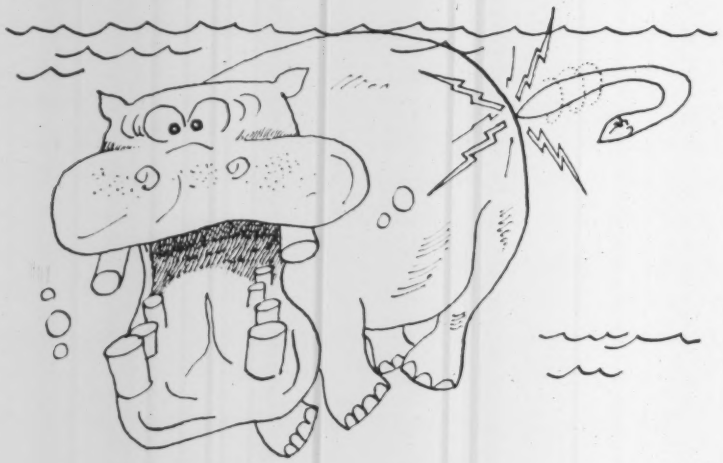
New Liquid-Metering System utilizes pipe mounted, straight-through Pottermeter which contains an elec-



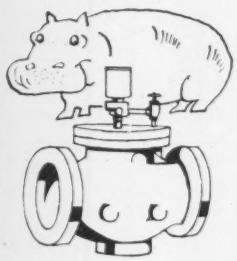
tric current-generating turbine-drive rotor. Electrical output is directly proportional to the rate of flow. Capacities are from 0.1 gpm to more than 40,000 gpm; temperature range is from −445°F to 1500°F. Accuracy is sustained at any velocity.—*Bowser, Inc., Pottermeter-Bowser Div.*, 1302 *East Creighton, Fort Wayne, Ind.*

For more information circle **217** on inquiry card.

OPENS ON ELECTRICAL IMPULSE



G-A *Cushioned* Solenoid Operated Valve



Where remote control valve operation is desired, specify and use the G-A Cushioned Solenoid Operated Valve that automatically opens or closes on any type of electrical impulse. The operating sequence—whether on open or closed circuit—can be made to suit your requirements. Sizes 2" to 36".

Bulletin W-7A has the complete story.

GOLDEN ANDERSON *Valve Specialty Company*

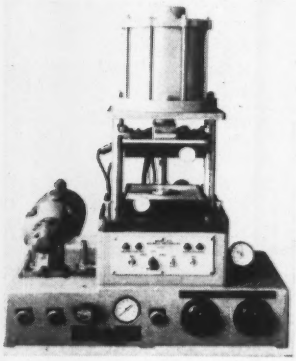
1281 RIDGE AVENUE, PITTSBURGH 33, PA.

Designers and Manufacturers of VALVES FOR AUTOMATION

For more information circle **104** on inquiry card.

MOONEY VISCOMETER

New automated Viscometer features controls which are preset to shut off after a specified time lapse



and/or at a specified viscosity. Automatic recording is concurrently done on a visual chart showing viscosity on the vertical scale and elapsed time on the horizontal. Temperature is also recorded in synchronization.—*Scott Testers, Inc.*, 45 *Blackstone St., Providence, R. I.*

For more information circle **218** on inquiry card.

ELECTRONIC TACHOMETER

New Tach-Pak, a self-contained Tachometer Unit, affords accurate measurement (0.25%) of the speed

of rotating, reciprocating or oscillating shafts or mechanisms. Input signals required are 5 mv. Outputs are 0 to 5 v with drive loads up to 3000 ohms. Magnetic pickup makes mechanical or electrical connection to the moving component unnecessary.—Bulletin F-53 gives details.—*Airpax Electronics Inc., Seminole Div., Fort Lauderdale, Fla.*

For more information circle **219** on inquiry card.

BREAK-GLASS SWITCHES

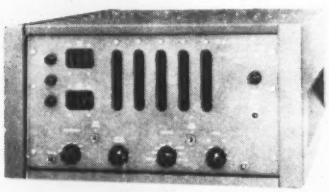
New line of heavy duty Break Glass Switches, rated 5 a, at 250 vac or 10 a at 125 vac is made in two forms of

control: (1) An SPDT switch connected to cause a mechanically-held remote control switch to open when the glass is broken, or (2) an SPST switch, suitable for 2 wire operated devices such as motor starters or solenoid valves, which opens when the glass is broken.—Bulletin 124 gives details.—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **220** on inquiry card.

FREQUENCY COUNTER

New Model 7153 EPUT Meter indicates whether metered frequency is below, within, or above two selected



limits by lighting one of three panel lamps marked "LO," "IN," or "HI." The frequency limits are selected by positioning two 4-digit decade switches. Relays can be used to actuate audible alarms or to control the source of the input frequency. Frequency range is dc to 100 kc., sensitivity is 0.1v rms into 10 Mohms. In controlling rotary speed, the input frequency is furnished by a tachometer that generates 1 to 180 cpr, and the output relays actuate brakes or apply power to the rotating element.—*Berkeley Div., Beckman Instruments, 2200 Wright Ave., Richmond 3, Calif.*

For more information circle **221** on inquiry card.

How UNION CARBIDE Verifies Flowmeter Accuracy

Operator testing flowmeter with COX Flow Calibration Standard

Periodic checking of liquid flowmeters at the huge Oak Ridge, Tennessee nuclear facility presented a problem to the Union Carbide Nuclear Company, operators of the facility. Checking the instruments required a known standard against which they could be evaluated. Using other flowmeters as masters was of questionable value as they too were subject to the same variables of wear, temperature changes, and viscosity shifts as were the instruments under test.

Union Carbide solved the problem by using a *COX Flow Calibration Standard* (Type 315), the same as those used by flowmeter manufacturers for original instrument calibration. It gives them a *primary standard* of their own — assuring accurate flow measurements that can be correlated with measurements by the National Bureau of Standards.

Costly? Not as much as you'd think for a *primary standard*. And the time normally spent on rechecking, evaluations, and analyzing test data was eliminated.

If you make or use flow measuring devices you will be interested in our new Technical Bulletin on *COX Flow Calibration Standards*. Write to: *Cox Instruments Division, George L. Nankervis Company, 15400 Fullerton Avenue, Detroit 27, Michigan.*

IF IT'S WORTH MEASURING
It's worth measuring accurately 7392

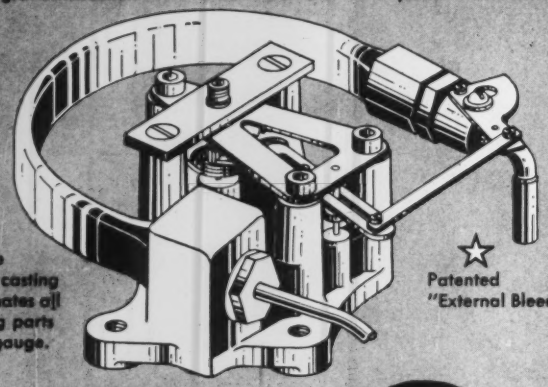
COX Instruments

For more information circle **105** on inquiry card.

HEISE GAUGES

Permanent positive accuracy of alignment guaranteed by integral construction.

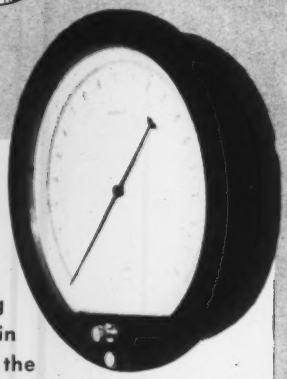
Weldless heat treated Bourdon tube maintains precise calibration.



Massive Bronze casting coordinates all working parts of the gauge.

Patented "External Bleeder"

Dial individually engraved with reference to the pressure gradient of its gauge mechanism.



ACCURACY

The standard of excellence maintained by Heise qualifies this instrument for the most exacting requirements. Designed to maintain permanently its inherent precision, the Heise gauge is often used in place of the dead weight tester in checking other instruments. Consistently accurate performance as a calibration reference has established its recognition as THE STANDARD OF THE WORLD.

SPECIALIZATION AND EFFICIENCY

Heise Laboratories have always specialized in the design and production of high precision pressure gauges. The highest standards of quality control protect the manufacture and assembly of each component and the permanent calibration of the finished instrument.

Efficiency in the production of one type instrument, precision pressure gauges, has made it possible to maintain a prompt delivery schedule.

DELIVERY WITHIN 30 DAYS.

Pressure Range 15 to 50,000 P.S.I.
Dial Sizes 8½"—12"—16"
Prices from $166.75

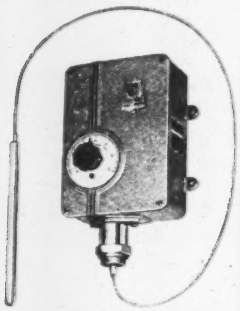
Catalog on Request

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **106** on inquiry card.

TEMPERATURE CONTROLLERS

New ZC and ZCC types of temperature controllers minimize shock and vibration hazards encountered in



transportation by use of a minimum of moving parts. The ZC Control, designed for multi-stage cooling or heating, is equipped with from 2 to 5 switches, each of which may be independently set to operate at any point on the scale. It is possible to set up any combination of up to four functions to operate in sequence on rise or fall of temperature. The multi-stage ZCC Control is identical with the ZC except for the addition of a separate auxiliary switch operated by the temperature set knob.—*Partlow Corp., New Hartford, N. Y.*

For more information circle **222** on inquiry card.

5000-VOLT POWER SUPPLY

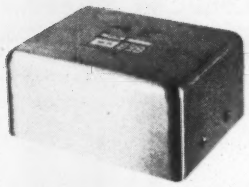
New Model HV-2C 5000-v Power Supply for gas proportional counters which use methane and other high

voltage gases, features dual-range continuously-variable output. Output ranges are 1000 to 25,000 v and 1000 to 5000 v. It will deliver 100 μa at up to 3000 v. Performance features include stability of ±6 v (high range) or ±4 v (low range), under normal conditions; voltage regulation of ±2 v (high range) or ±1 v (low range) for rated 105-125-v line variations; noise and ripple less than 25 mv rms. —*Technical Measurement Corp.*, 441 *Washington Ave., North Haven, Conn.*

For more information circle **223** on inquiry card.

TRANSISTORIZED POWER SUPPLY

New TPC-15 Transistorized Power Supply, specifically designed for airborne use, features a novel bridge-

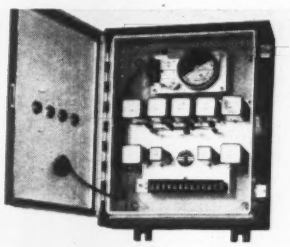


transistor circuit using low-voltage transistors to deliver 300 vdc at 150 ma, or 150 vdc at 300 ma from the aircraft 28-vdc battery source. Regulation is better than 5% over the entire output range and efficiency is better than 85%. Output is virtually free from ripple and noise.—*Southwestern Industrial Electronics Co.*, 10201 *Westheimer, Houston, Tex.*

For more information circle **224** on inquiry card.

AUTOMATIC PUMPING CONTROL

New Automatic Control, especially for oil well-, underpass- and pipe-line pumping, is a program timer control

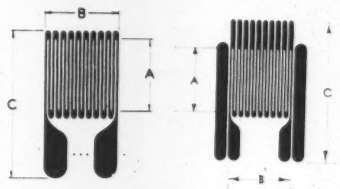


for use on gas, gasoline or diesel engines. All current is taken from the engine battery so that no commercial power is required.—*Synchro-Start Products, Inc., 333 N. Michigan Ave., Chicago 1, Ill.*

For more information circle **225** on inquiry card.

MAGNESIUM STRAIN GAGES

New C-15 line of Strain Gages, especially developed for use on magnesium parts, providing an extremely



low coefficient of resistance, is available in two classes: (1) the 101-Series for temperatures ranging from sub-zero to approximately +200°F; (like other gages in this series, C15's are ultra-flexible and very accurate), and (2) the 100-Series for temperatures to about +500°F.—*Tatnall Measuring Systems Co., Strain Gage & Transducer Dept., Box 245, Phoenixville, Penna.*

For more information circle **226** on inquiry card.

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defined by the dictionary

. . . . "the quality or state of being precise; accuracy; mechanical exactness."

defined by an instrument maker . . .

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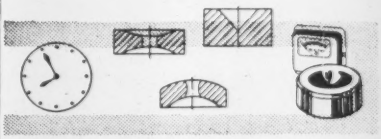

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- ACCURATE: Galvanometer pointer swings free for maximum accuracy, being clamped briefly for marking.
- INKLESS: Recording process is completely dry, utilizing special pressure sensitive paper. Method provides remarkable definition.
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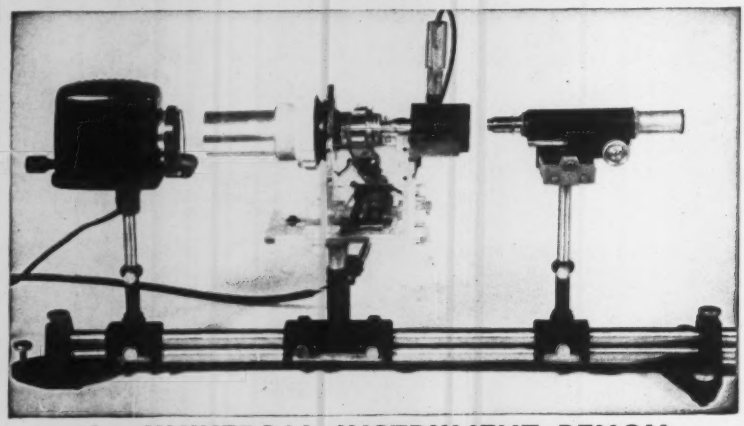

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For more information circle **110** on inquiry card.

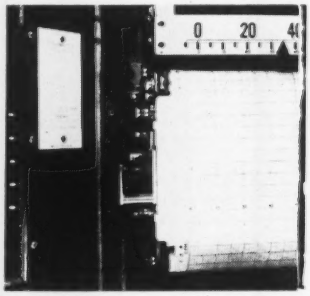
LONG-LIFE SOLENOIDS

New line of "long-life" Solenoids, designed for 100 million or more operations, has a machine-tool-type bearing as a plunger guide and features precision fit of guide and plunger.—*Automatic Switch Co., Florham Park, N. J.*

For more information circle **227** on inquiry card.

MULTI-SPEED CHART DRIVE

New Chart Drive for field mounting on any standard Bristol Dynamaster strip chart recorder allows in-



stant dialing of any of six different chart speeds without the need of stopping the chart. It provides great versatility of speeds to match varying recording requirements. Two standard models are available having overall ratio of 16:1 and 32:1.—*Insco Company, Div. of Barry Controls Inc., Groton, Mass.*

For more information circle **228** on inquiry card.

B+ SWITCHING COMPONENT

New Commutating Switch handles B+ switching at approximately 150 vdc, operating from a 6-vdc supply,

to provide 6 rps pole speeds. Switching section is comprised of a single pole with 12 make-before-break contacts with a maximum of 5% shorting time between contacts. It is capable of operating at −40°F at altitudes of 200,000 ft, while undergoing vibration spectrums represented by 20g from 20 to 2,000 cps.—*Instrument Development Laboratories, Inc., 67 Mechanic St., Attleboro, Mass.*

For more information circle **229** on inquiry card.

ELECTRIC COUNTERS

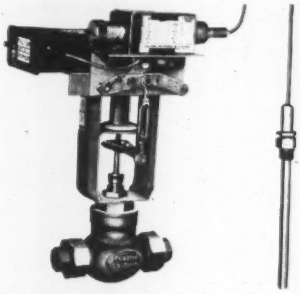
New pulse-grouping Electric Counters, counting pairs, quads, and other group quantities without pulse di-

vider circuits, are available in knob-reset basemount, knob-reset panel-mount, and key-reset panelmount models for ac or dc for all standard voltages to 150. A-c models have built-in full-wave rectification.—*PIC Automation Controls, General Controls Co., 8062B McCormick Blvd., Skokie, Ill.*

For more information circle **230** on inquiry card.

PROPORTIONAL CONTROLLER

New Fultro-Lectric Controller-Positioner-Valve combination features a shaded-pole, three-wire reversible



motor, driving the valve in the proper direction, when a switch assembly is actuated by a change in the measured variable (pressure or temperature). When the valve reaches the position called for by a small temperature sensing bulb, a feed-back switch quickly stops the motor.—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville 1, Tenn.*

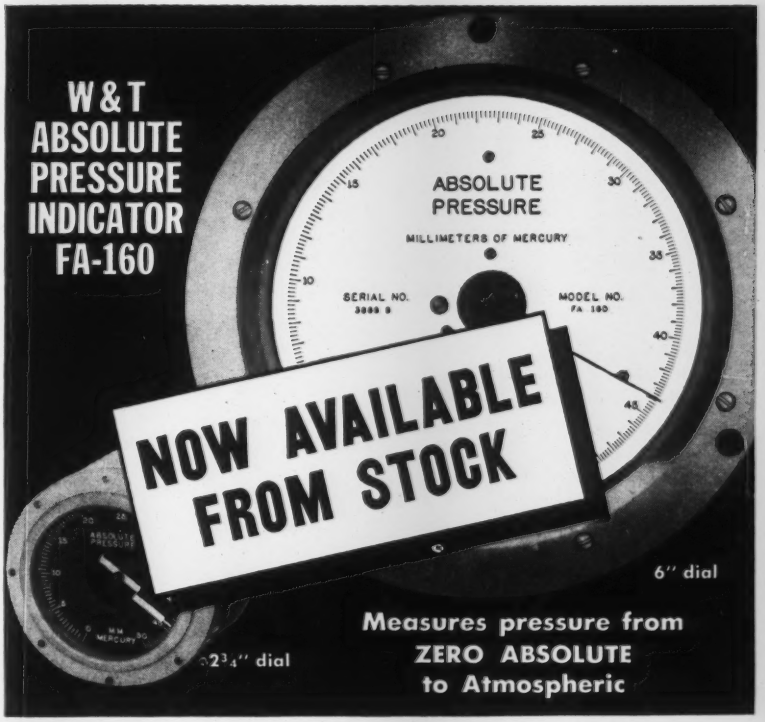
For more information circle **231** on inquiry card.

STORAGE BOX

New Kudl-Pak, a plastic box filled with a block of polyurethane foam, is a new type Storage Box for delicate

instruments and precision tools marketed by Navan Products, Inc., North American Aviation Subsidiary.—*Rocketdyne, 6633 Canoga Ave., Canoga Park, Calif.*

For more information circle **232** on inquiry card.



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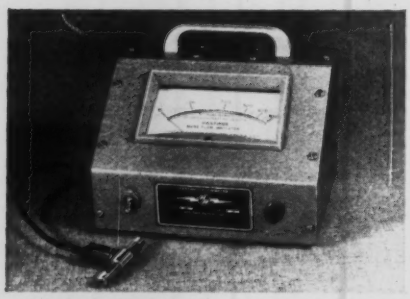
Calibrated directly in milligrams of air per minute. Especially well suited for measuring low rates of flow. Gives direct, continuous readings, holds calibration indefinitely, has low power requirements.



Hastings Model SM-1 Mass Flowmeter
Range: 0 - 500 milligrams of air per minute

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Range: 0 - 500 milligrams of air per minute. Relatively linear scale. Large mirror scale assures highest accuracy and easier readability. Ideal for remote indicating recording.

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For more information circle 114 on inquiry card.

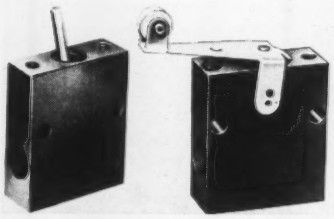
MICRO-MINIATURE RELAY

New Relays, with terminals located on 0.2" x 0.2" co-ordinates to permit mounting on printed circuit boards by automatic assembly techniques, operate under 100g shocks and 30g vibrations to 2000 cps with no contact openings in either armature position. Relays with single-coil action pull in at 260 mw at 25°C.; dual-coil latching relays at 230 mw. Both units have DPDT contacts rated at 2 a, 28 vdc, resistive.—*Potter & Brumfield, Inc., Princeton, Ind.*

For more information circle **233** on inquiry card.

MINIATURE VALVE

New Micro Valve, made in various sizes, with snap-action two-way, three-way, and four-way operators,

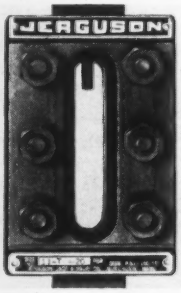


features fast positive action in virtually any gas or fluid service and bubble-tight shut off. Operating pressures are from 0 to 100 psig with orifice sizes up to ⅛". Various mechanical and solenoid operators as well as porting and manifold arrangements are offered.—*Instruments, Inc., P. O. Box 556, Tulsa, Okla.*

For more information circle **234** on inquiry card.

DRIP SIGHT FEEDER

New High-Pressure Drip Sight Feeder is used for corrosive conditions, for temperature conditions



from below zero to 750°F, or as a small flow indicator. The feeder incorporates a ⅛"-dia drip tube which extends into the upper portion of the chamber of a transparent-type flow indicator. Available with ½" or ¾" female or 1" male end connections.—Data Sheet Unit No. 350 contains details.—*Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.*

For more information circle **235** on inquiry card.

RESISTORS, RATIO SETS

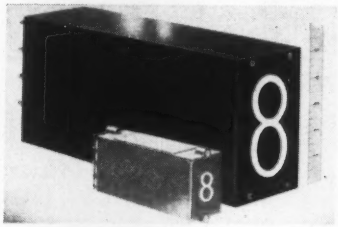
New NB-1-style line of laboratory-standard Resistors and Ratio Sets, with 0.0015% absolute and 0.005%

relative (ratio) accuracy, are oil-immersed, hermetically-sealed units, with these specifications—Range: (of individual resistances) 0.1 ohms to 10 megohms; (of ratios) up to 10^7:1, depending on overall resistance desired. Stability: resistors, 0.001%/year; ratios, 0.005%. Temp. Coefficient: resistors, 5ppm/°C, (available as low as 2.5ppm/°C); ratios, 2ppm/°C (available as low as 0.5ppm/°C).—*Julie Research Laboratories, Inc., 556 West 168th St., New York 32, N. Y.*

For more information circle **236** on inquiry card.

IN-LINE DIGITAL DISPLAY

New large In-Line Display Unit which is approximately four times the size of the standard unit has numbers and/or characters 3-¾" high by



2" wide, as compared with the 1"-high by ⅝"-wide size of the character in the standard in-line display.—*Industrial Electronic Engineers Inc., 3973 Lankershim Blvd., North Hollywood, Calif.*

For more information circle **237** on inquiry card.

GAS CHROMATOGRAPH

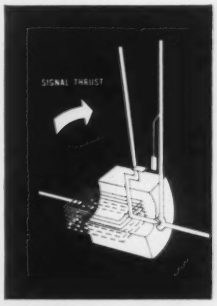
New high-performance Gas Chromatograph, Chromat-O-Flex Model 15, is designed for wide-temperature-range operation between ambient and 250°C. The detector is a shielded semi-flow type using high-resistance filaments to achieve high sensitivity and rapid response characteristics, while maintaining a very low noise level. Available accessories include a reproducible-volume gas sample valve, and electronic proportional temperature controller, a column reverse system, a sample collector, and staging adaptor tubes.—Other new products are Model 14 Process Chromatograph, and Model 1A Research Chromatograph.—*LOE Engineering Co., 237 North Fair Oaks, Pasadena, Calif.*

For more information circle **238** on inquiry card.

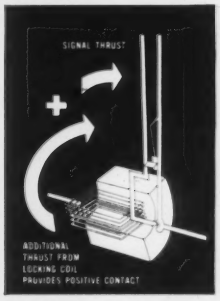
10,000,000 PERFECT OPERATIONS: reliability . . . achieved by the remarkable A.P.I. meter-relay

Suitable for any electrically-measurable variable, the A.P.I. meter-relay gives you sensitive monitoring, reliable control, combined in a single compact unit. It is an essentially simple instrument, yet a highly accurate and dependable one.

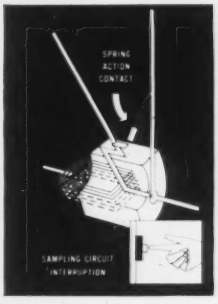
HERE'S HOW IT WORKS



1. Basically, the A.P.I. meter-relay is an indicating meter with built-in contacts. One contact is on the moving (signal-indicating) pointer; the other, on the adjustable (set-point) pointer. The indicating pointer is a free-moving element. The meter-relay has the high sensitivity inherent in a well-designed D'Arsonval movement.



2. At the instant of contact, a locking coil, wound integrally with the armature coil, supplements the torque developed in the meter movement. It is this locking coil — exclusively featured by A.P.I. — that assures positive contact every time. It holds the contacts together, maintains firm pressure to provide a good control circuit.



3. "Making" of the contacts loads the flexure spring on the set-point contact arm. When the contacts are released, they are immediately pushed apart by the force of the spring-loaded arm. There is no teasing or sticking; the break is decisive. Wiping action keeps contacting surfaces clean.

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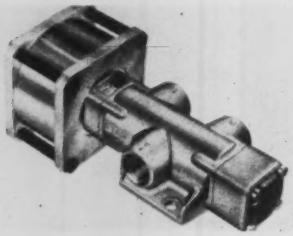
For more information circle **115** on inquiry card.

NEW INSTRUMENTS

DIAPHRAGM VALVE

New Versa Diaphragm Valve, can be actuated by pilot pressures as low as 5 psi (on double diaphragm types), or 10 psi (on standard spring return models). Only a small-capacity control valve is required to operate the



diaphragm valve, and actual volume of air used is less than 4 cu in per actuation. Available with either side-port bodies or for manifold mounting, and in sizes from ⅛" thru 1" NPT in 2-, 3-, 4- and 5-way types, and for pressures from partial vacuum to 500 psig.—*Versa Products Co., Inc.*, 249 *Scholes St., Brooklyn 6, N. Y.*

For more information circle **239** on inquiry card.

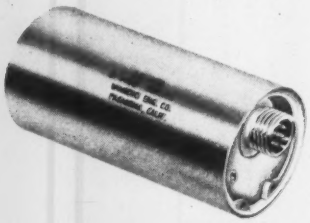
OPEN-SLOT TUBING DUCT

New Tubing Duct is a U-shaped plastic channel incorporating a continuous series of slots so arranged that instrument tubing on graphic panels can be snapped in or out at any desired termination point. It is fabricated from high-temperature nonflammable polyvinyl chloride in sizes from ½" x ½" to 3" x 4". Picture shows application in a graphic panel made by Customline Control Panels, Inc.—*Panduit Corp.*, 14461 *Waverly Ave., Midlothian, Ill.*

For more information circle **240** on inquiry card.

D-C ACCELEROMETERS

New D-C Accelerometers, Series 1111, combine a solid-state carrier oscillator and a ring demodulator with a variable-reluctance pickup. Advantages: continuous resolution; 0-5 vdc



output at constant impedance; low hysteresis; excellent linearity; and high natural frequency. Ideally suited for missile testing, and for use in airborne and ground-based data systems.—*Wiancko Engineering Co.*, 255 *N. Halstead, Pasadena, Calif.*

For more information circle **241** on inquiry card.

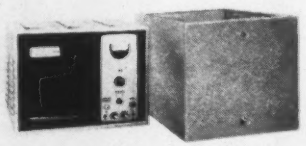
DOUBLE-COATED TAPE

New double-coated magnetic tape for use in continuous loop cartridges is using now Cousino Inc.'s patented lubrication process.—*Reeves Soundcraft Corp., Great Pastures Rd., Danbury, Conn.*

For more information circle **242** on inquiry card.

ULTRASONIC CLEANERS

New line of multi-purpose Ultrasonic Cleaners introduces a new concept in ultrasonic power, namely the consistent application of sufficient driving power to a precisely-designed transducer at the correct frequency,



which provides tremendous cavitational action and complete uniform coverage throughout the cleaning tank. Tank capacities are from 1 to 20 gal. The Barium titanate transducers are bonded under pressure to the bottom of the cleaning chamber. All tanks are of stainless steel.—*Circo Ultrasonic Corp.*, 50 *Terminal Ave., Clark, N. J.*

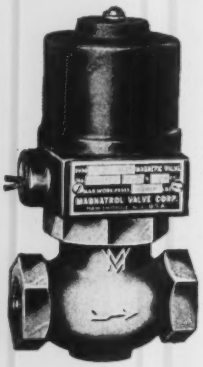
For more information circle **243** on inquiry card.

Eliminate

Costly Flow Failures

Magnatrol

SOLENOID VALVES



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For more information circle **118** on inquiry card.

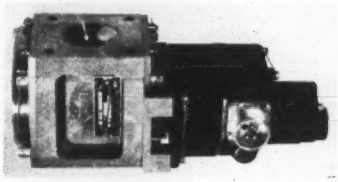
CRYOGENIC LEVEL SENSOR

New Level Sensor System for the measurement and control of liquids in the cryogenic field, including hydrogen, helium, oxygen, and nitrogen is based on the Delta C Detector, an encapsulated unit measuring $\frac{1}{16}$" x 1-1/13" x 2-$\frac{5}{8}$" using semiconductors throughout. Applications include both airborne and ground-support operations in the missile and space fields.—*Trimount Instrument Co., 3119 West Lake St., Chicago 12, Ill.*

For more information circle **244** on inquiry card.

BALL VALVE

New Venturi-Flow Ball Valve line features metal-to-metal seats and minimal envelope dimensions. The venturi-like configuration of its flow

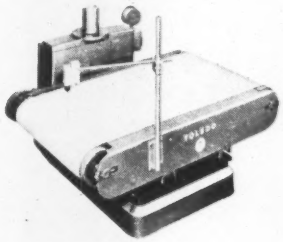


passage permits use of a small ball, thereby minimizing overall size and weight. Hand-, solenoid-, and motor-operated versions are available.—2-page Data Sheet WF 1538 gives details.—*Waldorf Fluid Systems, A Div. of F. C. Huyck & Sons, Wolf Hill Rd., Huntington Station, L. I., N. Y.*

For more information circle **245** on inquiry card.

AUTOMATIC CHECKWEIGHER

New Model 9460 Automatic Checkweigher, featuring a belt-type motorized conveyor on the weigh section, will handle packages (depending on size) at speeds of up to 40 items/min with an accuracy of approximately one part in 3000. Continuously check-



weighs bags, cartons, boxes, packages, blocks, cans, or tubes (from 50 to 200 lb) with equal speed and accuracy without stopping the item on the scale. Magnetic counters of the key-reset-type can provide numerical data. It is also capable of operating reject mechanisms, audible signals and trend indicators.—*Toledo Scale, Div. of Toledo Scale Corp., Toledo, Ohio.*

For more information circle **246** on inquiry card.

OUTSELLS THEM ALL!

HERE'S WHY

1 2½ to 1 ratio – guide length to guide diameter–prevents galling and hanging up.

2 High thermal expansion rate of sleeve guide and low thermal expansion rate of hardened stem retainer eliminates binding and galling even at elevated temperatures.

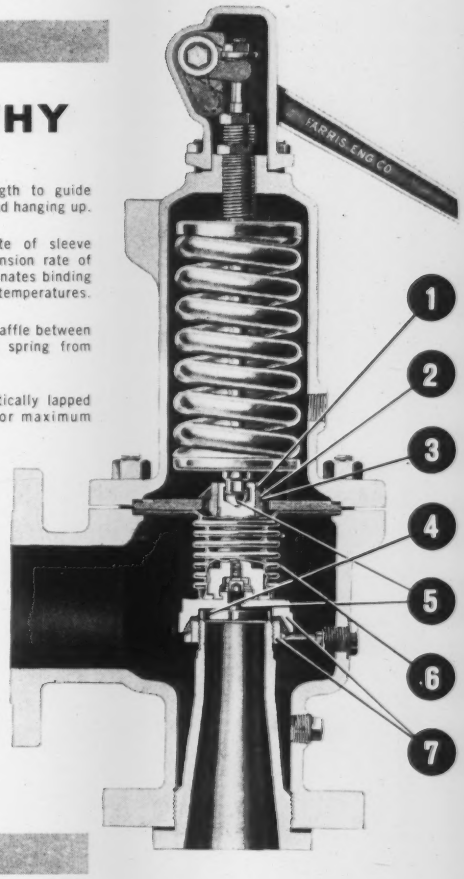
3 Sleeve guide provides solid baffle between body and bonnet, shielding spring from lading fluid.

4 Hardened stainless steel optically lapped flat disc – self aligning for maximum tightness.

5 Double universal ball joint from stem to disc for self alignment – eliminates effects of spring, temperature and piping distortion.

6 Stainless steel "BALANSEAL" bellows nullifies effect of back pressure and isolates internal working parts from lading fluid.

7 Cone-shaped disc holder directs flow away from guiding surfaces and forms fixed secondary orifice with single blowdown ring control for built-in capacity.



Farris full nozzle Safety-Relief Valves

Simplicity in design, safety in operation . . . what more can you ask of a Safety-Relief Valve! The patented design features shown in this Farris valve have been *standard* for more than a decade. It's the ideal concept of a trouble-free, safe, safety valve, free from inventory and design change problems since 1945. It's the *preferred design* in full nozzle safety-relief valves for the process industry.

Detailed information for the selection and sizing of all Farris process safety-relief valves is in Catalog FE-118. Sent to you on request.

PROGRESS THROUGH HONEST PURPOSE

Farris ENGINEERING CORP.

706 Commercial Avenue, Palisades Park, N.J.

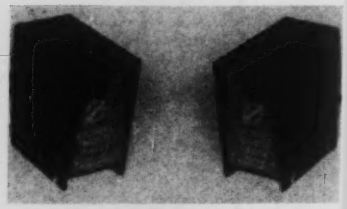
Texas Plant: 5405 Clinton Drive, Houston 20

affiliates: FARRIS FLEXIBLE VALVE CORP. • FARRIS PICKERING GOVERNOR CO., INC. • FARRIS ENGINEERING LTD., LONDON, ENGLAND

For more information circle **119** on inquiry card.

ELECTRONIC CONTROLLER

New Decitron, Model K-5, a new multi-purpose Electronic Controller, features a hermetically-sealed solid-



state photocell and d-c operated SPDT relay. Can be used as an on-off, go/no-go controller and will sense up to 1000 interruptions/min.—*Post Machinery Co., Electronic Products Div., 151 Elliott St., Beverly, Mass.*

For more information circle **247** on inquiry card.

MAGNETIC-TAPE AMPLIFIERS

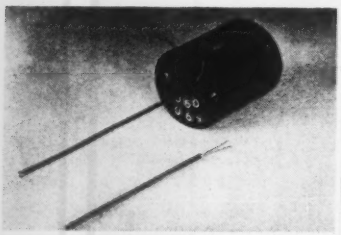
New Model 921 family of Write/Read Amplifiers offers a choice of d-c level or pre-selected pulse width

for output use. D-c level or pulse is also acceptable for input to write amplifier. Tape speeds from 1 in/sec to 150 in/sec can be accommodated, with a response to minimum signal levels as low as 150 mv. Other significant features are: gated output for direct strobing, clock playback for data strobing, IBM clock generation, and choice of read/write switching mode.—*Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, N. Y.*

For more information circle **248** on inquiry card.

WIRE STRIPPER

New Stripper for small wires of swaged tubular-sheath mineral-insulated thermocouple wire is available

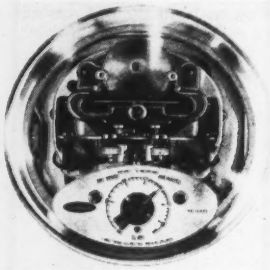


in four sizes of sheath O.D. as follows: 0.128" to 0.122", 0.068" to 0.064", 0.064" to 0.060", and 0.044" to 0.040".—*Bruce W. Stowe Co., 7149 Dodgeon Court, Cincinnati 31, Ohio.*

For more information circle **249** on inquiry card.

CONTACT-MAKING METER

New Contact-Making Meter for controlling or regulating a-c voltages has a moving disc (induction type) measuring element of high sensitivity which will detect voltage variations as small as ½ v. A set of adjustable contacts on the movement is used to actuate a built-in power relay which will handle loads up to 20 amps direct-



ly. The contact action can be set at any increment between 100 v and 130 v. The mode of control is of the two-position (HCL) type with adjustable differential gap. The contact spacings can be set individually to yield a control differential from ½ v to 6 v. The set point can be readily changed or adjusted in the field. These contacts are used to provide control, indication or alarm functions.—*Technique Associates, A Div. of Duncan Electric Co., Inc., P.O. Box 90, Indianapolis 6, Ind.*

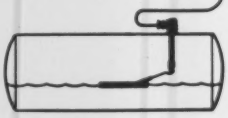
For more information circle **250** on inquiry card.

100% AUTOMATIC TANK GAUGING

Dependable remote reading tank contents gauges using a closed hydraulic transmission system. No power required.

Several sizes available. Approved by Underwriters Laboratories and Factory Mutual. UL approved switches.

Write for complete details, to Dept. E



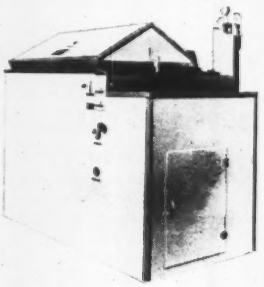
Since 1920 of proven quality

THE LIQUIDOMETER CORP.
LONG ISLAND CITY 1, NEW YORK

For more information circle **121** on inquiry card.

DEVELCO

SALT SPRAY FOG TEST CHAMBER



To meet MIL-E-5272 B and others.

TOP OPENING
FRONT OPENING
WALK-IN

DEVELCO

DEVELOPMENT ENGINEERING COMPANY, INC.

9 Cross Street • Norwalk, Connecticut

• *Manufacturers of Environmental Test Equipment*
Fungus Testing - Cold - Heat - Altitude - Humidity

For more information circle **122** on inquiry card.

DATA PROCESSING DEVICE

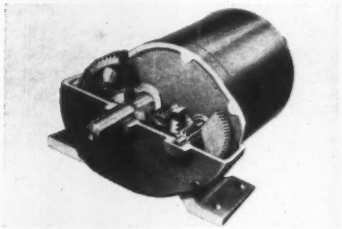
New Data Punch, consisting of a Custom Line full-keyboard Adding Machine which activates a Tape Punch, operates at a rate of 20 digits/sec on power supplied by the adding machine. It produces two records si-

multaneously: (1) a detail strip (receipt) for immediate accounting data, and (2) a punched tape which can be directed to digital computers and processors. Information on the punched tape can be converted to punched cards or magnetic tape for further processing. Keyboard input may be either electric or manual.—*Victor Adding Machine Co.*, 3900 *N. Rockwell St., Chicago* 18, *Ill.*

For more information circle **251** on inquiry card.

LOW-COST GEARMOTOR

New low-cost Gearmotor VW10, using an integrally mounted ¼-hp 115-vac split-phase motor, provides speeds of 30, 60, or 120 rpm, and develops



torque of up to 433 in-lb. The electrically-reversible permanently-lubricated unit has the motor mounted directly to the gear housing, thus eliminating alignment problems.—2-page bulletin gives details.—*Von Weise Gear Co.*, 9353 *Watson Industrial Park, St. Louis* 19, *Mo.*

For more information circle **252** on inquiry card.

PHOTOELECTRIC HEADS

New miniature Exiter Lamp and Photo-Cell units can operate up to 10,000 counts/min, depending upon

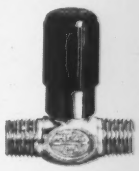
the electronically-operated relay unit used which are made in three models of varying capacities.—*Worner Electronic Devices, Box* 10, *Rankin, Ill.*

For more information circle **253** on inquiry card.

Industry's big **DEMAND** for small valves keeps growing every day. A few years ago, Hoke's old plant was more than adequate... the product line was limited to a handful of styles. But along came nuclear energy and mass spectrometry and automation. So our lines grew and grew.

HOKE now manufactures:

Bar Stock Valves to handle high pressures



Packless Valves to resist corrosion, hold high vacuum

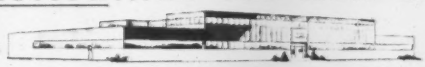
Metering Valves to throttle down to a trickle

Check Valves to control one-way flow

Toggle Valves to flip on-off quickly

Pressure Regulators to reduce high pressures accurately

Plus many other types, too. And we're not only making more, we're making them faster...with every Hoke Valve leak tested...in our new automated plant.



When you need **QUALITY** small valves, delivered promptly, tell us your requirements. We'll gladly send you our catalog with specific recommendations.

Hoke Incorporated,
31 Piermont Rd., Cresskill, N.J.

HOKE

For more information circle **123** on inquiry card.

5 KINDS

ESTERLINE-ANGUS WATTMETERS

for every power measurement

	Potential Rating (Volts)	Current Rating (Amperes)
AC		
2 current element	100/200/500	5 or 10
3 current element	100/200/500	5 or 10
4 current element	100/200/500	5, 10 or 20
DC		
2 current element	100/200/500	5, 10 or 20
AC-DC		
2 current element	100/200/500	5, 10 or 20

What They Are—Ask for Catalog Section 33.
What You Can Do With Them—Ask for Bulletin 939A.

Product Representatives in Most Principal Cities

The ESTERLINE-ANGUS Company, Inc.
Pioneers in the Manufacture of Graphic Instruments
Dept. G, P. O. Box 569, INDIANAPOLIS 6, INDIANA

For more information circle **124** on inquiry card.

LEAK PROOF VALVES . . .
Replaceable Soft Seat
Metering or Flow

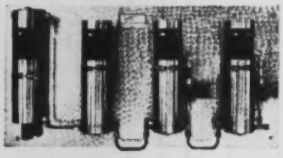
HI-VACUUM TO 6,000 PSI

PNEUMATIC HYDRAULIC
ANGLE—GLOBE—THREE PORT—MANIFOLD

ROBBINS Aviation, Inc.

2350 E. 38th St.—Los Angeles 58, Calif.

DEHYDRATION



Remove moisture & oil vapor from gases with working pressures up to 12,000 PSI; dew points -100°F.

For more information circle **125** on inquiry card.

MEGACYCLE METER

0.1 Mc to 940.0 Mc

Model 59-LF Oscillator 100 Kc—4.5 Mc

Model 59 Oscillator 2.2 Mc—420 Mc

Model 59—UHF Oscillator 420 Mc—940 Mc

Write for Bulletin

Determines resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, etc. Measures inductance and capacitance. Also used as a signal generator, wave meter, frequency meter, and in many other applications.

This compact, lightweight grid-dip meter is available in the frequency ranges indicated.

Laboratory Standards

MEASUREMENTS
A McGraw-Edison Division
BOONTON, NEW JERSEY

For more information circle **126** on inquiry card.

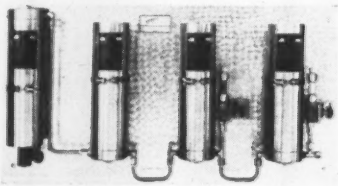
AC VOLTAGE REGULATORS

New Selenivac line of heavy-duty electromechanical a-c Voltage Regulators is for 25, 50, 60- or 400-cycle operation and provides ±1% control with no waveform distortion. Input voltages may be one-phase, two-phase (3 or 4 wire) and three-phase. Present line includes ratings from 1 kva to 300 kva and any input or output voltage up to 600 v.—*American Rectifier Corp., 95 Lafayette St., New York 13, N. Y.*

For more information circle **254** on inquiry card.

DEHYDRATION EQUIPMENT

New RAF-D4B Dehydration System uses disposable cartridges for dehydration applications in missile and aircraft-ground-support pneumatic systems, and other applications calling

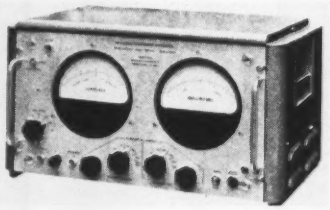


for dry oil-free gas. Pressure range is 600 psig to 12,000 psig with flow rates as high as 550 scfm. Minus 100°F dewpoint and oil vapor content of less than ½ ppm by volume are obtainable. Can be used with air, nitrogen or helium.—*Robbins Aviation, Inc., 2350 East 38th St., Los Angeles 58, Calif.*

For more information circle **255** on inquiry card.

VTVM

New Model VP 250-A is said to represent an entirely new concept in vacuum tube voltmeters. The unit displays on two separate meters the rms-values of both in-phase and quadra-



ture components of input signal voltage with respect to a given sine wave reference voltage of the frequency. Resolved-components indicator measures transmission characteristics, power frequencies and related electrical, electrohydraulic and electromechanical functions. Frequency Range:—20 cps to 20 kcps. Accuracy of indication:—±2% of f.s.d. on all ranges. Voltage ranges: reference—15 mv to 20 v; signal—15 mv to 15 v. —*Solartron, Inc., 530-532 Cooper St., Camden 2, N. J.*

For more information circle **256** on inquiry card.

LOAD INDICATOR

New mode-sensing Digital Indicator, Model DTI-2 eliminates manual polarity switching for load-cell and torque-measuring systems common in torque measurements of reaction-type dynamometers which cycle from ab-

sorbing to motoring; and in use of shaft torque pick-ups, where shafts change from clockwise to counter-clockwise rotation. It automatically senses whether a strain-gage load cell is in tension or compression and indicates the proper mode on front panel lamps. Accuracy is 0.1% of full scale. Standard response is 10 sec full scale. Instrument is portable, or can be supplied for rack-mounting.—*Performance Measurements Co., 15301 West McNichols Rd., Detroit 35, Mich.*

For more information circle **257** on inquiry card.

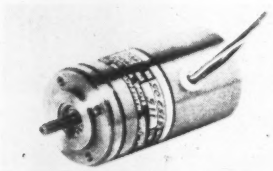
VIBRATING CAPACITOR

New VC-1006/500 Vibrating Capacitor uses ceramic insulation resulting in a minimum insulation resistance of 10^{12} ohms. Contact potential is 30 mv maximum and drift is ±2 mv/day.—4-page Catalog 523-A contains details.—*Stevens-Arnold, Inc., 22 Elkins St., South Boston, Mass.*

For more information circle **258** on inquiry card.

VISCOUS-DAMPED MOTOR

New Type 5752-05 adjustable Viscous-Damped Motor, size-11, is smaller, lighter and more economical than a motor tach used in feedback damping applications. It consumes less power and presents no null or phasing



problems in the feedback loop. Damping and gain may be independently adjusted. No-load speed can be quickly adjusted to between 4800 and 7300 rpm. Unit can be built in a standard BuOrd Mark 14 characteristic. Meets MIL-E-5272A. Ambient temperature range: −55°C +125°C.—*John Oster Manufacturing Co., Avionic Div., 1 Main Street, Racine, Wis.*

For more information circle **259** on inquiry card.

HIGH DISSIPATION RESISTORS: Space-wound, mica-insulated types for instruments, business machines and other exacting uses. Operate continuously at 175°C dissipating 7½ watts in air or 15 watts against metal.
HEAVY-DUTY PRECISION RESISTORS: Wound with glass-insulated, low-TC wire, "G" Type resistors handle 5-10 times the wattage of standard-size precision types. Available in 1½ to 20-watt types with full-load tolerances to 0.25%
SURGE RESISTORS: Used in high voltage rectifiers, as high current meter multipliers, or as bleeders, these resistors handle 150 watts up to 22½ KV. 100 ohm to 3 megohm types available with 1% tolerances standard.
CORONA-PROTECTED RESISTORS: Ideal for corona control in kilovoltmeters, these Taylor-type high voltage resistors consist of five 0.1% Shallcross resistors mounted in spun aluminum cases. Each unit handles 5 KV (7½ KV max.). Several units may be screwed together for measurements up to 200 KV.
EXTERNAL METER RESISTORS: Sectional wirewound resistors fitted into hermetically-sealed, glazed Steatite tubes with ferrule-type terminals. Resistances up to 6 megohms, ratings from 1¼ to 5 watts at voltages up to 6 KV. Standard tolerances 0.5%; 0.05% on request.

Special Wirewounds
for the TOUGH JOBS

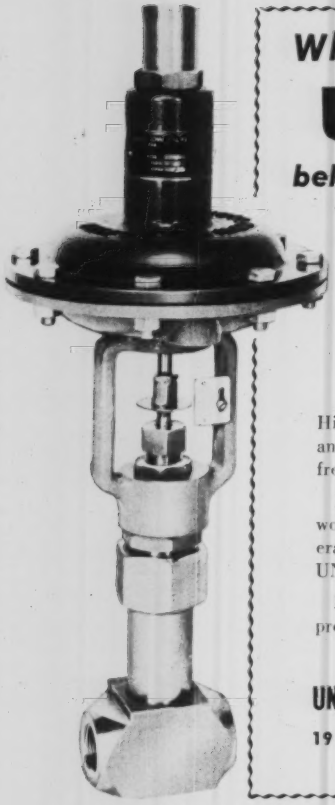
When your resistor applications call for the unusual in shape or size . . . the critical in terms of performance and reliability . . . consider Shallcross. Chances are that after 30 years of designing and manufacturing precision wirewound resistors, even the most extraordinary requirements can be met.

Beyond the "specials" shown above, Shallcross regularly produces the widest selection of highly reliable ceramic and encapsulated wirewound resistors available today.

Inquiries for specific types will receive prompt attention. SHALLCROSS MANUFACTURING COMPANY, 12 Preston Street, Selma, N. C.

Shallcross

For more information circle **127** on inquiry card.



Why the NEW
Uniflow
bellows seal valve . . . is BEST

- ►SEMI-STEEL TOP WORKS
- ► TOP WORKS PROPERLY SIZED FOR VALVE BODY
- ► TOTALLY ENCLOSED SPRING
- ► BELLOWS SEAL—PLUS TEFLON PACKING FOR SAFE OPERATION
- ► REMOVABLE PLUG WITHOUT REPLACEMENT OF BELLOWS

High quality materials, engineering know-how and superior design assures long maintenance-free operation under many process conditions.

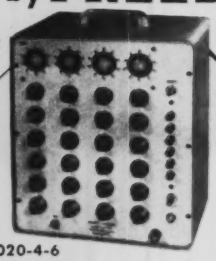
If you are now using valves with bulky top works and are experiencing corrosion and operational problems, check and compare UNIFLOW VALVES TODAY.

Requests for descriptive literature handled promptly. Write direct to . . .

UNIFLOW VALVE CORPORATION
19 QUINE ST., CRANFORD, N. J.
BR 6-8300

For more information circle **128** on inquiry card.

NEW!! MULTIPLE PRESET COUNTER by FREED



TYPE 2020-4-6

The Freed Type 2020-4-6 Multiple Preset Counter was designed for sequential predetermining control and is ideally suited for applications when a machine or a process is started manually and stops automatically at several preset counts in one operation. One of the applications for this counter is the winding of tapped toroidal or transformer coils.

Premium components, simplified circuits, using a minimum of computer type vacuum tubes and a silicon diode power supply provides reliable maintenance free operation.

SPECIFICATIONS

- **MAXIMUM COUNT:** 4 digits 9,999
- **COUNTING RATE:** 4000 per second
- **PRESETS:** 1-6
- **INPUT:** Photocell, Switch closure, Pulse
- **OUTPUT:** Relay DPDT — 5 Amp contacts
- **SIZE:** 11 x 13 x 8⅝ inches
- **WEIGHT:** 19½ lbs.
- **POWER SUPPLY:** 105-125 Volts—50-60 cycles

Freed also manufactures Preset, Totalizing, Batching and Timing counters.

Send for complete information.

FREED TRANSFORMER CO., INC.
1707 Weirfield St., Brooklyn (Ridgewood) 27, N.Y.

For more information circle **129** on inquiry card.

Miniature Surface FAST-RESPONDING THERMOCOUPLE

New Design Features Offer for the First Time a Thermocouple with:

- A Response Time of Less than 10 Microseconds
- A Maximum Continuous Service Temperature of Over 2000°F.
- An Operating Pressure Range to 50,000 psi
- A Sensing Tip with unlimited Life

Revolutionary design uses thin ribbon thermocouple wires and mica insulation of .0002 inches thickness. Will operate under extremely high velocity and high pressure conditions.

Available in iron-constantan, chromel-alumel, or platinum-platinum/10% rhodium standard thermocouple elements.

For additional details and models write for Bulletin No. TB 159.

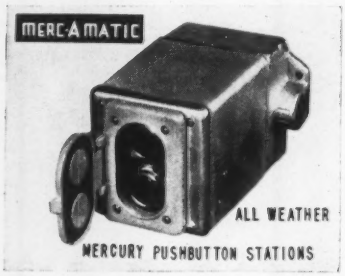
NANMAC CORPORATION
P. O. Box 8, Indian Head, Md.

For more information circle **130** on inquiry card.

NEW INSTRUMENTS

PUSHBUTTON STATIONS

New series of Merc-Amatic pushbutton stations with mercury contactors provides for many component ar-



rangements for outdoor use, and all applications where dust-free service is indicated. The pushbutton operators are located under a hinged cast spring access door.—*Tigerman Engineering Co., 4332 N. Western Ave., Chicago, Ill.*

For more information circle **260** on inquiry card.

HIGH-VOLTAGE TEST SETS

New model Test Set wich 200 kv rms output for testing high-voltage tubes, cables and bushings, all dielectric materials, and high voltage apparatus in general, in accordance with ASTM testing methods, is available in many sizes from 2 kva to 100 kva.—*Peschel Electronics, Inc., R.F.D. #1, Towners, Patterson, N. Y.*

For more information circle **261** on inquiry card.

VAPOR FRACTOMETER

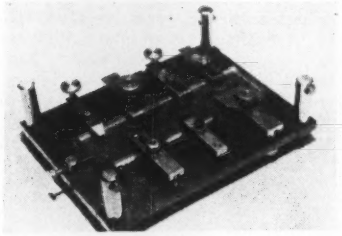
New high-resolution high-sensitivity Vapor Fractometer, Model 208, includes a flame ionization detector (giving high sensitivity) and new

high-resolution Golay, or capillary columns. Samples of approximately 10^{-9} grams can be handled, and at 160°F it will separate hydrocarbon components from C_5-C_{12} in a reasonable time, whereas a conventional packed column of the same substrate might conveniently separate only C_5-C_{11} at the same temperature. High signal levels permit use of galvanometric rather than the more costly potentiometric-type recorder.—*Perkin-Elmer Corp., Instrument Div., Norwalk, Conn.*

For more information circle **262** on inquiry card.

JIG AND FIXTURE PLATES

New complete line of stock Precision Ground Jig and Fixture Plates, $\frac{3}{16}$", ¼", ⅜" or ½" thick, is avail-



able in stainless steel or aluminum. All surfaces are flat and parallel to within ±0.0005", with an overall 32 μin ground finish.—*PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.*

For more information circle **263** on inquiry card.

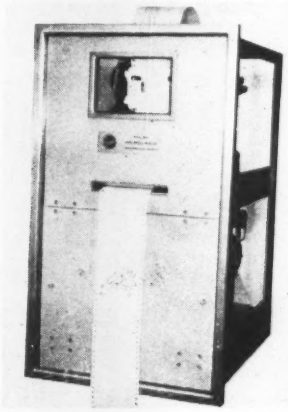
DIGITAL METERS

New universal power input connectors have been incorporated in the NLS 481 Digital Voltmeter and the NLS 781 Digital Ohmmeter which allow their use with 50-cycle 220-v as well as 60-cycle 110-v power supplies. —*Non-Linear Systems, Inc., Del Mar, Calif.*

For more information circle **264** on inquiry card.

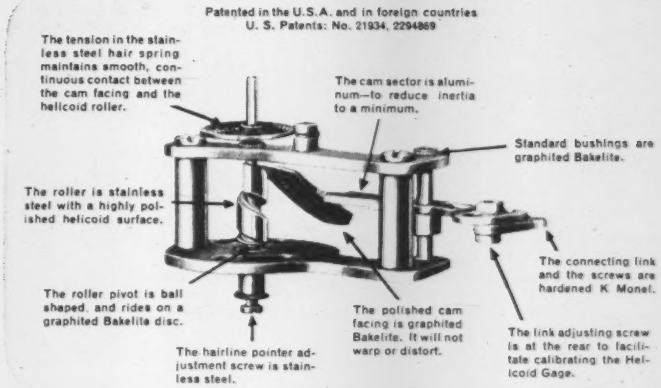
ALPHANUMERIC PRINTER

New Potter Model 3260 Alphanumeric Printer accepts data from any source of digital information such as digitizers, magnetic or perforated tapes, electronic counters, or computers. Printout rate is 48,000 digits/



min. As a logger of digitized data from a series of analog-to-digital converters a scan and printout rate of 200 3-digit numbers per second is realizable. Up to 63 characters are available in alphabetical, numerical, and special symbols in any desired combinations.—*Potter Instrument Co., Inc., Plainview, N. Y.*

For more information circle **265** on inquiry card.


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details **Ask for Catalog G-52**

HELICOID GAGES

Helicoid Gage Division • American Chain & Cable Company, Inc.
929-B Connecticut Ave., Bridgeport 2, Conn.

For more information circle **131** on inquiry card.

PHOTOCON ELECTRO-MAGNETIC COUNTERS

—compact, reliable units for telemetering readout and control

These Photocon counters add and/or subtract electrical pulses at speeds up to 20 counts per second. Each digit on each wheel has a contact, for remote indication or control. Counters available with precision resistors mounted between contacts. Counter provides an analog or digital output.

High accuracy—there is no gain or loss of counts over a life of 10,000,000 counts. A balanced armature insures accurate counting during severe vibration.

High reliability—contacts are made from precious metals to eliminate contact noise. Wearing parts are built of Nylon for long life.

Small size—only 1 13/16" high x 3½" wide x 3¼" deep. Weight is only 22 ounces. Available in 3-, 4-, and 5-digit counters...also in shaft-driven models. Units can be preset, and hand reset. Write for literature on Photocon Model MCP-1005.

PHOTOCON RESEARCH PRODUCTS
421 North Altadena Drive, Pasadena, Calif.

A Complete Line of Electro-Mechanical Counters and Digital Clocks

For more information circle **132** on inquiry card.

Flow Visualization Instrumentation

Schlieren Systems
Shadowgraphs
Interferometers
Wind Tunnel Optics
Mountings & Piers
Packaged Systems

Catalog upon request

John Unertl Optical Co.
3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **133** on inquiry card.

MACHINE-DIVIDED SCALES

Made with latest SIP Swiss Automatic Dividing Machines

LINEAR
Accuracy to ±5 microns (0.0002")
CIRCULAR
Accuracy to ±5 seconds

Any scale pattern—Any line width—Any material

FINE MACHINE ENGRAVING
Scales, Dials, Drums, Rods, Panels
ACCURATELY ETCHED RETICLES
Made to any specified pattern and dimensions

PROMPT DELIVERY
on large or small quantities.

L. C. RENICK CO.
308 So. Salsipuedes St., Santa Barbara, Calif.
formerly Cicero, Illinois

For more information circle **134** on inquiry card.

NEW INSTRUMENTS

MULTIPLE METER

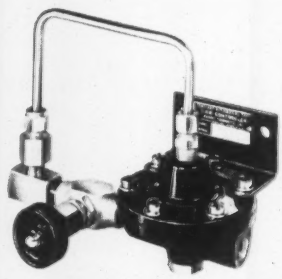
New Model MV-77A DC Multimeter combines accurate, sensitive measurement of millivolts and micro-amperes with an accurate, linear-scale ohmmeter. Measuring accuracy is 1% of full scale on all voltage ranges, 1% of full scale on all ohm-measuring

ranges, and 3% on all current ranges. The instrument has a total of 39 measuring ranges 0-1 mv through 0-1000 v, 13 current ranges 0-1 μa through 0-1a, and 13 ohmeter ranges 0-1 ohm through 0-1 megohms.—2-page Bulletin 703 gives details.—*Millivac Instruments Div. of Cohu Electronics, Inc., P. O. Box 997, Schenectady, N. Y.*

For more information circle **266** on inquiry card.

FLOW CONTROLLER

New "very-low-flow" Controllers measure liquid flows as low as 2 cc/min or air flows as low as 30 scc/min. They maintain a constant differential across a needle valve, capillary,

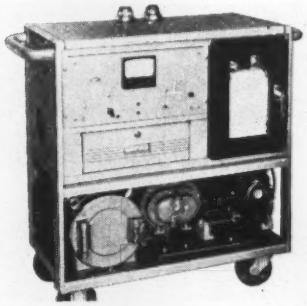


or other restrictor, regardless of line pressure changes, and provide a constant mass flow which is a function of the needle valve setting. Applications include gas chromotography, purge systems, pilot plants, and process-blending operations. Rangeabilities of 500:1 or higher are possible. Bulletin AD63-6 contains technical data.—*Moore Products Co., H & Lycoming Sts., Phila. 24, Pa.*

For more information circle **267** on inquiry card.

AIR MONITOR

New Model AM-2A Air Monitor detects alpha, beta and gamma activity; records the amount of activity on a continuous chart; and warns by



light and bell when preset limits are exceeded. It includes a new type Mylar window flow G-M detector (Model FMG-1), all-transistorized amplifier, and fixed filter. Maximum counting rate is 50,000 cpm.—*Nuclear Measurements Corp., 2460 North Arlington Ave., Indianapolis 18, Ind.*

For more information circle **268** on inquiry card.

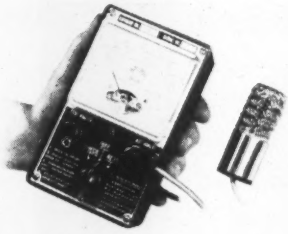
ITV

New Model 1986 System has built-in, fully automatic light-adjustment control which will instantly adjust to variations in light level of up to 1000:1. System consists of Model 1986C Camera, Model 1986ACU Camera Control Unit, and Model DRM-14R Monitor. The bandwidth of the video amplifiers is 8 megacycles, ±0.5 db. A transistorized stable full count-down sync generator provides EIA standard pulses, either crystal-controlled, line-locked, or free-running.—*Cohu Electronics, Inc., Kin Tel Div., 5725 Kearny Villa Rd., San Diego 12, Calif.*

For more information circle **269** on inquiry card.

RELATIVE-HUMIDITY INDICATOR

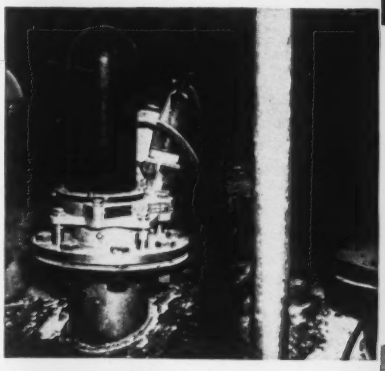
New portable Electro-Hygrometer indicates relative humidity electronically from as far as 100 feet away, without use of tubes, conversion



charts, thermometers, or water connections. Humidity range is 30% to 95% (within a temperature range of 32°F to 180°F); accuracy is ± 5%.—*Labline, Inc., 3070 W. Grand Ave., Chicago 22, Ill.*

For more information circle **270** on inquiry card.

YES, NOW VISCOSITY

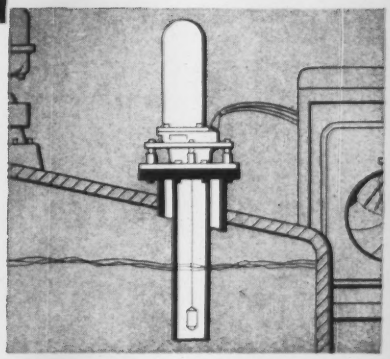


CAN BE CONTINUOUSLY

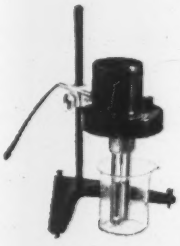
PROCESS CONTROLLED

WITH THE

BROOKFIELD VISCOMETRAN



UNDER actual process conditions, the Brookfield Viscometran accurately and continuously measures, records and controls viscosity. Readily mounted and integrated in existing processes, the Viscometran offers significant economic advantages over other methods of indicating degree of reaction, degree of polymerization or determination of process end point.



Viscosity is very likely a variable that is fundamental in your process. For complete information about how the Brookfield Viscometran can provide continuous "in process" measurement of this product dimension for you, write—

THE WORLD'S STANDARD FOR VISCOSITY MEASUREMENT AND CONTROL

Brookfield

ENGINEERING LABORATORIES, INCORPORATED

STOUGHTON 316, MASSACHUSETTS

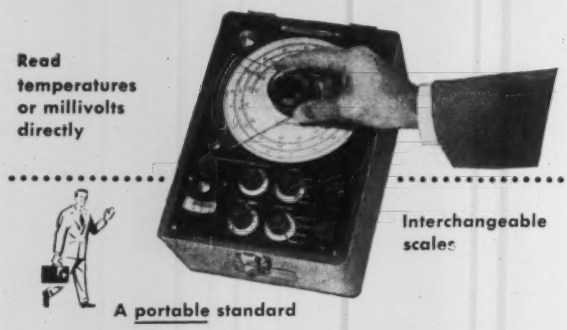
BROOKFIELD VISCOMETRANS NOW SUCCESSFULLY USED FOR CONTROLLING:

Asphalt • Caramel • Cement slurries • Durezresin-acetone slurries • Gluten slurries • Lignum-based polymers • Molten P_2S_5 • Paper coatings • Polystyrene • Polyurethane resins • Ureaformaldehyde resin

For more information circle **135** on inquiry card.

Calibrate Pyrometers

. . . Measure Temperatures



The Pyrotest checks recorders, controllers and thermocouples . . . measures temperatures. It is a precision signal source, simulating thermocouple temperatures, for checking other potentiometers. Built-in "run up" permits checking of millivoltmeters.

19 different stock scales will fit one Pyrotest! Scales interchange in seconds. °F. or °C. calibrations for all types of thermocouples supplied. Scales directly read temperatures or millivolts.

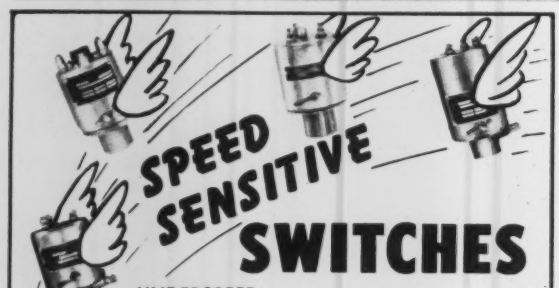
Features include cold junction compensation, high accuracy, built-in standard cell. Request Bulletin 9B for complete specifications.

TECHNIQUE **TECHNIQUE ASSOCIATES**

A Division of Duncan Electric Co., Inc.

P. O. BOX 91 • INDIANAPOLIS 6, INDIANA

For more information circle **136** on inquiry card.



SPEED SENSITIVE SWITCHES

UNDERSPEED
One S.P.D.T. switch to trip at speeds as low as 400 RPM. Maximum operating speed 5,000 RPM.

OVERSPEED
One S.P.D.T. switch to trip at speeds between 500 and 6,000 RPM.

OVER and UNDERSPEED
Two S.P.D.T. switches to trip at two different speeds between 500 and 6,000 RPM.

OVER—INTERMEDIATE and UNDERSPEED
Three S.P.D.T. switches to trip at three different speeds between 1,200 and 6,000 RPM.

Speeds above or below those listed above must be referred to our Engineering Department for special consideration. Request Bulletin 504 describing our Speed Sensitive Switches.

SYNCHRO-START PRODUCTS
INCORPORATED
8151 N. RIDGEWAY AVENUE, SKOKIE, ILLINOIS
Automatic Engine Control Sets—Safety Alarm Sets—Special Control Panels—D. C. Solenoids—Heavy Duty Relays

For more information circle **137** on inquiry card.

new plants and mergers

ELECTRONIC ASSOCIATES' new addition to their plant at West Long Branch will provide an additional 57,000 sq ft of manufacturing area.

SIMPSON ELECTRIC CO. has purchased the Case Company Building in Elgin, Ill. with over 250,000-sq-ft office and production space for a future expansion into that area.

HEWLETT-PACKARD CO. has awarded a 2-million-dollar contract for the construction of two 85,000-sq-ft buildings and a 50,000-sq-ft underground warehouse at its plant in Stanford Industrial Park.

HISONIC, INC. is a new electronics firm in the Kansas City are specializing in custom electronic components.

MID-CENTURY INSTRUMATIC has changed its name to COMPUTER SYSTEMS, INC.

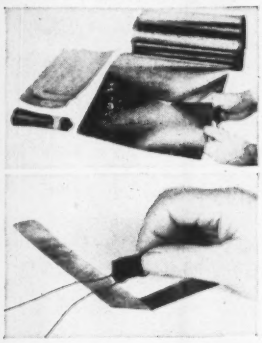
FENWAL INCORPORATED announces establishment of an independent Monitor and Control Division.

CDC CONTROL SERVICES has changed its name to CompuDyne Corp.

M-H BELTSVILLE DIV. has expanded into a plant leased in Laurel, Md.

THIN VERSATILE DUCTILE NETIC CO-NETIC FOIL

Aids Miniaturization & Reliability . . . Cuts to Any Shape with Scissors . . . Wraps like Tape . . . Shields Both High & Low Frequencies at Low Intensities



One or more layers are readily applied and their effects observed, permitting engineer to determine optimum location and number of layers needed for adequate shielding. Can be trimmed to any dimension or outline with ordinary scissors. Easily formed by hand. Dead soft; does not spring back into original position after forming. Aids miniaturization by reducing shielding bulk and by making possible crowding components closely together.

15" wide Co-Netic foil is non-shock sensitive, non-retentive, does not require periodic annealing and attenuates low level fields. When used with 19⅜" wide Netic foil, higher ratios of attenuation for relatively intense fields are achieved. Both foils are immediately available from stock in .004" thickness in continuous rolls up to any length desired.

These versatile light weight time-saving foils open up a whole new shielding concept in laboratory, air borne, electronic, electrical and shielded room applications. Write for complete details today.

MAGNETIC SHIELD DIVISION PERFECTION MICA COMPANY
1322 No. Elston Avenue, Chicago 22, Illinois
Originators of Permanently Effective Netic Co-Netic Magnetic Shielding

For more information circle **138** on inquiry card.

SCOVILL MFG. CO. recently unveiled its new $10 million copper and brass tube mills in New Milford, Conn.

CONSOLIDATED SYSTEMS CORP., wholly owned subsidiary of **CEC**, is building a 10,000-sq-ft addition to its plant in Monrovia.

people in the news

R. Milham

G. H. Gleason

W. T. Hadley

FOXBORO CO. has appointed *Russell Milham* manager and *Gerald H. Gleason* supervisor of international sales; also *William T. Hadley* assistant advertising manager.

BRUSH INSTRUMENTS, Div. of Clevite Corp. has named *William K. Whittemore* manager of its eastern regional office.

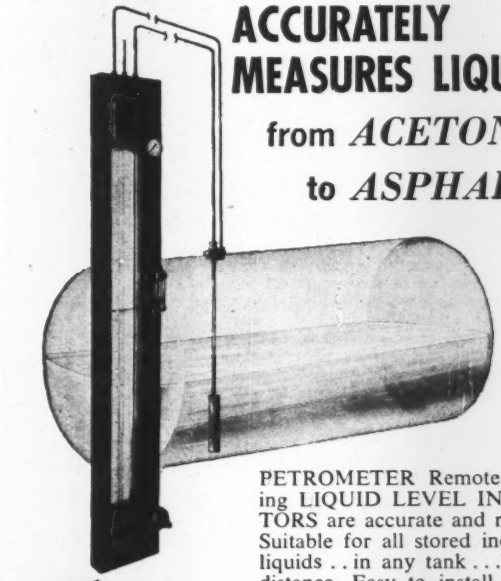
JAMESBURY CORP. has appointed *W. G. "Bill" Hurd* southeastern district manager.

CHARTS
for Recording Instruments

We offer to the Instrument Maker Charts for all methods of Recording: Pen, Ball Point, Electrical, Thermal, Pressure and Metallic Stylus.

Uniform accuracy is assured through the use of specialized equipment operated under controlled atmospheric humidity conditions.

GUBELMAN
CHARTS INCORPORATED
100-6 E. KINNEY ST., NEWARK 5, N. J.



ACCURATELY MEASURES LIQUIDS
from *ACETONE*
to *ASPHALT*

PETROMETER Remote Reading LIQUID LEVEL INDICATORS are accurate and reliable. Suitable for all stored industrial liquids . . in any tank . . . at any distance. Easy to install . . . and easy to read. Indicators have many unique design features.

write today for Bulletin 6004.

PETROMETER
CORPORATION
43-22 TENTH ST. LONG ISLAND CITY 1, N. Y.

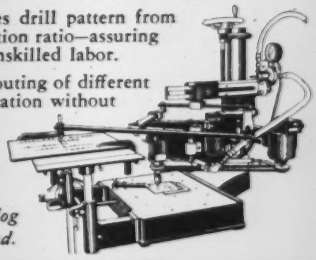
For more information circle **139** on inquiry card.

LEWYT DRILLS PRINTED CIRCUITS 110% FASTER
with Engravograph

Writes Lewyt engineer Murray Berman:

"...Not only did New Hermes Engravograph increase our production by this amazing figure, but it also enabled us to achieve consistently better quality."

- Pantograph reproduces drill pattern from template in any reduction ratio—assuring high accuracy with unskilled labor.
- Allows drilling and routing of different size holes in one operation without changing tools.



Also for tracer-guided
ENGRAVING • PROFILING
GRADUATING

Request our 28-page catalog XP-2 on your letterhead.

new hermes ENGRAVING MACHINE CORP
154 West 14th Street, New York 11, N. Y.

For more information circle **140** on inquiry card.

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE
CAMBRIDGE 40 MASSACHUSETTS
TRowbridge 6-3368—3369

A LIST OF MATERIALS WE FABRICATE USED IN OPTICS AND ELECTRONICS

SAWING GRINDING POLISHING DRILLING

ALUM
ALUMINA
ALUMINUM
ANTHRACENE
ARSENIC TRISULPHIDE
BARIUM TITANATE
BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COBOLT FERRITE
COPPER
*CORNING 707
*CORNING 7052
CUPROUS BROMIDE
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GALLIUM ARSENIDE
GARNET
GERMANIUM
GOLD
INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM FERRITE
MAGNETIC PLUMBITE
MELAMINE FIBER GLASS
MICA, SYNTHETIC
NICKEL OXIDE
PLATINUM
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITANATE
TEFLON
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

* Carried in stock
** Purchased for orders

For more information circle **141** on inquiry card.

D. W. Smith

F. D. Herbert, Jr.

R. W. Lee

KEARFOTT CO. announces election of *Donald W. Smith* as chairman of the board, and *Fred D. Herbert, Jr.* as president.

GENERAL PRECISION LAB announces that *Richard W. Lee* has been elected president, *William P. Hilliard* vice president and general manager, and *William J. Tull* vice president, avionic engineering and sales.

Edward V. (Ned) Platt

Edward V. (Ned) Platt, president of Paragon Electric Co., died May 20 at West Palm Beach, 61 years old. Mr. Platt started with Paragon in 1921 as a salesman and rose to the positions of sales manager, vice president in charge of sales, and executive vice president before being elected president in 1943. He is survived by his wife, three daughters, two sisters, and a brother, George J. Platt, who is executive vice president at Paragon.

Announcing

A NEW 54-PAGE CATALOG OF DEWAR FLASKS

The most comprehensive listing of standard and special Dewar flasks ever published.

A large variety of standard flasks is listed that can be supplied from stock for both regular laboratory use and cryogenic research. Also included are many possible variations which can be produced to aid your engineers in designing special shapes for work in the low temperature fields with liquid hydrogen and helium. MARTIN-MADE Dewar flasks are highly evacuated at high temperatures and all are manufactured without separation pads. Write today for your copy.

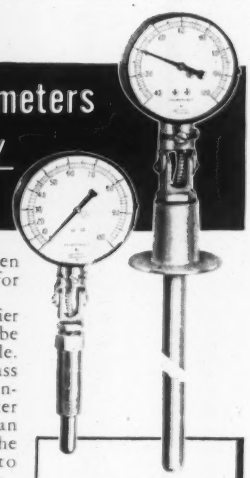
H. S. MARTIN & SON
1916-20 GREENLEAF STREET • EVANSTON, ILLINOIS

SCIENTIFIC GLASSWARE OF SUPERIOR QUALITY

For more information circle **142** on inquiry card.

New!

Marsh Dial Thermometers *designed expressly* for piping and ducts

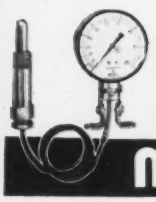


Here you have everything that has been so long needed in thermometers for piping and duct work.

Big 3½" and 4½" dials are far easier to read; still more important, can be turned and tilted to *any* reading angle.

Instead of illegible, breakable glass tube, you now have the readable, unbreakable Marsh—the thermometer that gives greater *readable* accuracy than any glass tube thermometer and has the famous Marsh "Recalibrator" to *keep* it accurate.

Complete line provides for every service. Separable sockets and swivel attachment nuts make connecting and disconnecting easy. Extension necks provide for insulated piping and ducts.



New bulletin covers interesting details

Jas. P. Marsh Corporation
Dept. 42, **Skokie, Illinois**

Marsh Instrument & Valve Co. (Can.) Ltd. • 8407 103rd St. Edmonton, Alberta, Can.

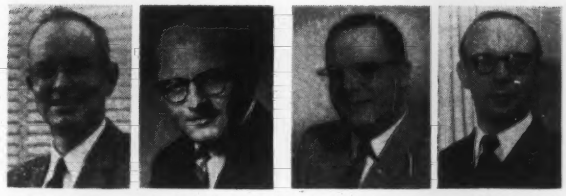
MARSH

FOR PIPING
Ranges: 0°—100° F, 20°—120° F, 40°—240° F and 100°—300° F. ¾" NPT male connection.

FOR DUCTS
Ranges: minus 40°—120° F, 0°—160° F, 0°—220° F. Long stems extend into ducts for accurate indication.

Also available in remote reading types with 6 ft. tubing. Same ranges, sockets, stems, dial sizes.

For more information circle **143** on inquiry card.



B. H. Billings H. G. McDonell J. F. Clough B. W. Pollard

BAIRD-ATOMIC has named *Dr. Bruce H. Billings* assistant director of research and engineering.

PERKIN-ELMER announces appointment of *Horace G. McDonell* as sales manager of the Instrument Division.

DYNAMETRICS CORP. has appointed *John F. Clough* general sales manager.

BURROUGHS CORP., ElectroData Div. announces appointment of *Brian W. Pollard* as assistant to the general manager.

AUDIO DEVELOPMENT CO. announces appointment of *Newell Sprecher* as engineering manager.

HAMMEL-DAHL DIV. General Controls Co. announces appointment of *William R. Kennedy* as sales manager.

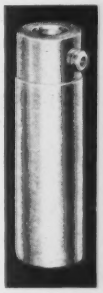
PANELLIT SERVICE CORP. announces that *Marvin B. Lorig* has been appointed vice president and general manager.

MARSH INSTRUMENT CO. announces the election of *Bernhard Willach* as vice president for engineering.

NORCROSS **VISCOMETERS**

for Automatically Measuring Viscosity in the process with the

PROVEN FALLING PISTON



Typical Applications:

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2-End Point Determination—Viscosity is automatically recorded during polymerization and other chemical processes. All changes show as they occur so that the process can be terminated at the correct viscosity.

3-Starch Processes—A Recording Viscometer is used to automatically control starch cooking or enzyme converting to finish each batch accurately to the desired viscosity.

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HIGH SENSITIVITY
RUGGED CONSTRUCTION
SELF CLEANING
WIDE VISCOSITY RANGE

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For more information circle **145** on inquiry card.

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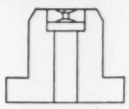
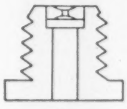
for AIRCRAFT • ELECTRICAL MECHANICAL and MARINE INSTRUMENTS





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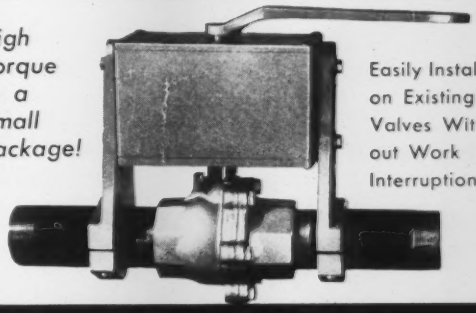

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Models for ¼" to 8" valves. Provides positive indicated control at any distance, yet allows manual operation or over-ride at any time. Operates on AC or DC by manual switch or automatic applications such as timer, thermostat, float, pressure switch, etc. In event of power failure, valve can be manually operated.

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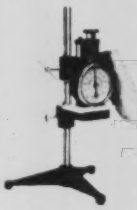

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FOR TESTING THE HARDNESS OF RUBBER & RUBBER-LIKE MATERIALS (ASTM D676) (ASTM D1484)

SHORE INSTRUMENT & MFG. CO., INC.
90-35 VAN WYCK EXP. JAMAICA 35, N. Y.

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Here's an instrument that pays for itself over and over again! How? By assisting in product development and manufacture—and by eliminating costly errors in viscosity control.

Operating on the falling-ball principle, the Hoeppler Viscosimeter has an accuracy of 0.1% to 0.5%. Even gases as well as liquids, oils, plastics, syrups, viscous tars, etc., can be measured. Only a small sample (30cc) is required, and the results are consistent and reproducible.

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new literature

CONTROL SYSTEMS

AUTOMATIC CONTROL PANELS. 4-page Bulletin describes Pantro panels, lists uses by industry, and provides informative data on specific applications.—Control Panel Corp., 517 West Monroe St., Chicago 6, Ill.
For more information circle **271** on inquiry card.

PANEL BOARDS. 8-page folder contains pictures and descriptions of control panel boards and/or electrical systems. Interior front cover of folder carries design tables useful to engineers and designers.—U. S. Controls Inc., 410 Fourth Ave., Brooklyn 15, N. Y.
For more information circle **272** on inquiry card.

AUTOMATIC SYSTEMS. 4-page bulletin illustrates and lists techniques for sorting, counting, positioning, weighing, and inspection.—Atronic Products Inc., Bala-Cynwyd, Penna.
For more information circle **273** on inquiry card.

MOTORS, SERVOS

ROTARY COMPONENTS. 28-page Catalog SC-3-59 presents data on synchros; precision computing resolvers and linear transformers (induction potentiometers); servo motors and motor generators; and gearhead motors.—Clifton Precision Products Co., Inc., 9014 West Chester Pike, Upper Darby, Penna.
For more information circle **274** on inquiry card.

SERVOMOTORS. 11-page Servo-Brief 1583 contains technical data concerning the use of inertia- and velocity-damped servomotors.—Helipot Technical Information Service, Beckman/Helipot Div., 2500 Fullerton Rd., Fullerton, Calif.
For more information circle **275** on inquiry card.

SELSYN MOTORS & GENERATORS. 6-page Bulletin CEC-1527 describes selsyn systems for a wide variety of applications.—General Electric Co., Schenectady 5, N. Y.
For more information circle **276** on inquiry card.

SMALL MOTORS. 8-page Catalog R-1 describes four types of a-c shaded pole, reversible, nongeared motors.—Barber-Colman Co., 1300 Rock St., Rockford, Ill.
For more information circle **277** on inquiry card.

MANUAL STARTERS. 8-page Bulletin 11-B1 details full specs and data of motor starters.—Furnas Electric Co., Batavia, Ill.
For more information circle **278** on inquiry card.

VALVES

NON-RETURN VALVE. 8-page Bulletin S-2-B describes a single-acting, non-return valve which opens automatically when boiler pressure equals header pressure.—Golden-Anderson Valve Specialty Co., 1285 Ridge Ave., Pittsburgh 33, Pa.
For more information circle **279** on inquiry card.

SOLENOID VALVES. 36-page Catalog 444 lists complete line of over 200 solenoid valves of bronze and stainless steel construction.—Atkomatic Valve Co., 545 West Abbott St., Indianapolis 25, Ind.
For more information circle **280** on inquiry card.

THREE-WAY VALVES. 4-page Bulletin 8F describes line of three-way feedwater heater bypass valves for regulating boiler feedwater flow.—Schutte and Koerting Co., Dept. V-E, Cornwells Heights, Bucks County, Penna.
For more information circle **281** on inquiry card.

SAFETY RELIEF VALVES. 84-page Comprehensive Catalog 88, gives detailed information on full line of safety relief valves.—Marine & Industrial Products Co., North Wales, Penna.
For more information circle **282** on inquiry card.

SPLIT-BODY CONTROL VALVES. 8-page Bulletin 117 describes and illustrates diaphragm-operated valves for process, chemical, and petroleum industries.—Uniflow Valve Corp., Cranford, N. J.
For more information circle **283** on inquiry card.

AIR CONTROL VALVES. 12-page Bulletin 234 features an informative discussion of air valves and their selection together with condensed catalog listings, presented in an educational manner.—Hannifin Co., a div. of Parker-Hannifin Corp., Dept. 300, 501 South Wolf Rd., Des Plaines, Ill.
For more information circle **284** on inquiry card.

REGULATOR PILOT. 2-page catalog sheet describes the Fig. 8000 supersensitive pressure regulator pilot.—Atlas Valve Co., 280 South St., Newark 5, N. J.
For more information circle **285** on inquiry card.

PUMPS, FLOW, LEVEL

RECIRCULATION CONTROL. 2-page Bulletin 560 contains details on a pump recirculation control system to maintain adequate pump flow at all times.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.
For more information circle **286** on inquiry card.

RING BALANCE METERS. 8-page Bulletin MSP-160 describes the many applications for Hagan Ring Balance Meters.—Hagan Chemicals & Controls, Inc., Controls Div., Box 1346, Pittsburgh 30, Pa.
For more information circle **287** on inquiry card.

LIQUID-LEVEL AND FLOW. 24-page Bulletin ERS-A describes applications of liquid-level and flow controllers.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.
For more information circle **288** on inquiry card.

LIQUID-LEVEL CONTROL. 2-page Bulletin 3004 describes Series 1800 liquid level controls.—Petrometer Corp., 43-22 Tenth St., Long Island City 1, N. Y.
For more information circle **289** on inquiry card.

FLUID PROPORTIONING. 2-page Bulletin 1140.20A-1 describes use and application of Model 1140 Proportioneers Adjust-O-Feeder for chemical and industrial fluid proportioning.—B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R. I.

For more information circle **290** on inquiry card.

WEIGHT, FORCE, PRESSURE

VACUUM TECHNOLOGY. 4-page issue of "Welch Digest," Vol. 1/No. 7 contains 6 briefs with illustrations from scientific magazines dealing with vacuum technology.—W. M. Welch Mfg. Co., 1515 Sedgwick St., Chicago 10, Ill.

For more information circle **291** on inquiry card.

REMOTE WEIGHT RECORDING. 8-page Form 2975a describes remote digital weight recording systems.—Toledo Scale, Div. of Toledo Scale Corp., Toledo 12, Ohio.

For more information circle **292** on inquiry card.

AUTOMATIC FILLING SCALES. 4-page bulletin illustrates and discusses ten main types of automatic scales.—Thayer Scale Corp., Thayer Park, Pembroke, Mass.

For more information circle **293** on inquiry card.

UNDER-OVER WEIGHT INDICATOR. 2-page Bulletin 58B describes panel-mounted meter that indicates weighing deviations in terms of dial scale division.—Richardson Scale Co., Clifton, N. J.

For more information circle **294** on inquiry card.

TORQUEMETERS. 2-page bulletin describes Series 85 torquemeters for measuring dynamic torques.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

For more information circle **295** on inquiry card.

STRAIN GAGES. 6-page Bulletin 4320 describes SR-4 etched foil gages.—Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 42 Fourth Ave., Waltham 54, Mass.

For more information circle **296** on inquiry card.

COUNT, TIME

IMPULSE COUNTERS. 4-page condensed catalog illustrates and describes all types of Sodeco impulse counting devices.—Landis & Gyr, Inc., 45 West 45th St., New York 36, N. Y.

For more information circle **297** on inquiry card.

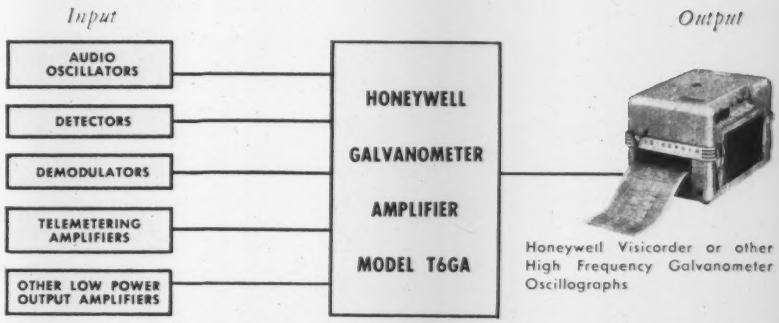
COUNTERS, TIMERS. 12-page catalog describes 32 instruments and accessories such as universal counter/timers, frequency-period meters, frequency meters, time interval meters, incline-inplane readouts, electronic gono-go gages, preset counter controllers, and decade counting units.—Computer Measurements Co., 5528 Vineland Ave., North Hollywood, Calif.

For more information circle **298** on inquiry card.

TACHOMETERS. 14-page binder contains information and specs on tachometers and adapters, flexible

NEW GALVANOMETER AMPLIFIER

Strengthens Low Power Signals to Drive High Frequency Oscillographs



Galvanometer Amplifier, Model T6GA-1, measures 3½" high, 19" wide, 15½" deep.

DESCRIPTIVE DATA

VOLTAGE GAIN:
Adjustable from 0 to 1.0

OUTPUT (37 OHM LOAD):
±2.4 volts at 65 ma d-c to 8 Kc, limits at ±100 ma.

OUTPUT IMPEDANCE:
2 Ohms d-c to 10 Kc

CONTROLS:
6 GAIN controls, 1 Power ON-OFF switch

INPUT IMPEDANCE: 47 K

ISOLATION:
Individually floating channels for use with ungrounded loads

NOISE:
Less than 3 mv peak-to-peak

DRIFT:
Less than 3 mv/°F

POWER REQUIREMENTS:
115 volts ±10 volts, 50 to 440 cps, 45 watts

With Honeywell's new Galvanometer Amplifier, Model T6GA-1, high frequency oscillographs can now be operated directly by low power input sources of 1 volt or more. These inputs, some of which are shown in the diagram above, should have output impedances of 10 K or less although higher source impedances can be tolerated. Noise and drift are indistinguishable on the recorded output when the galvanometer-amplifier combination has a maximum sensitivity of 1 inch per volt.

The Model T6GA-1 is a compact, six channel, three stage transistor d-c amplifier with overload protection to eliminate both danger of transistor damage and galvanometer burnout.

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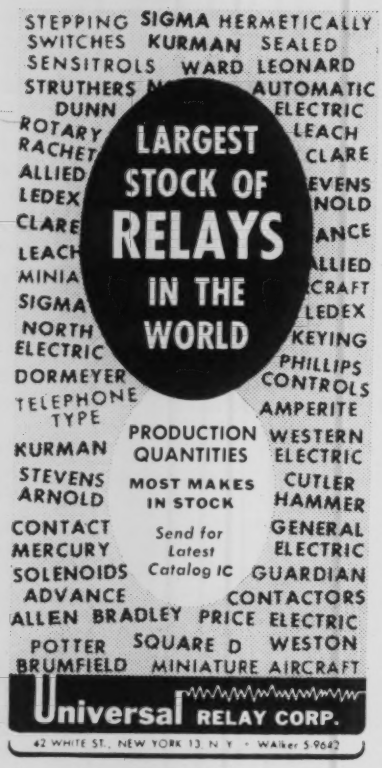

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NEW LITERATURE

shafts, mileage recorders, etc.—Barbour Stockwell Instruments, 80 Cambridge St., Worcester 3, Mass.

For more information circle **299** on inquiry card.

AIR, HUMIDITY

SPACE FILTERS. 8-page Bulletin 1505-5 describes and illustrates a new space filter, designed with high dust carrying capacity and replaceable filter elements.—Mine Safety Appliances Co., 210 North Braddock Ave., Pittsburgh 8, Pa.

For more information circle **300** on inquiry card.

RELATIVE HUMIDITY RECORDER. 2-page Data Sheet ND46-92(1) gives complete information on Model S relative humidity recorder.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

For more information circle **301** on inquiry card.

AIR AND GAS DRYERS. 6-page Bulletin R-34 covers compressed air and gas dryers.—Desomatic Products, Inc., 1109 West Broad St., Falls Church, Virginia.

For more information circle **302** on inquiry card.

DEHYDRATION SYSTEMS. 68-page Catalog No. 1159 covers dehydration, refrigeration, mechanical filters, driers and purifiers, vapor indicators, metering valves, oxygen valves, fittings, etc.— Robbins Aviation, Inc., 2350 East 38th St., Los Angeles 58, Calif.

For more information circle **303** on inquiry card.

OPTICAL

PHOTOGRAPHIC AUTOMATION. 24-page Booklet "Photographic Automation in Science and Industry," is devoted to the multiple uses of automatic photography with the Robot electro-automatic photo-recording system.—Karl Heitz, Inc., 480 Lexington Ave., New York 17, N. Y.

For more information circle **304** on inquiry card.

SPECTROSCOPES. 4-page Product Bulletin 154-58 describes and illustrates spectroscopes of the Bunsen-Kirchoff type.— Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

For more information circle **305** on inquiry card.

VIBRATION

DAMPING MATERIAL. 24-page Bruel & Kjaer "Technical Review" TRI, and 16-page TR2 describe techniques and theory for measurement of the damping effect of surface coating material for reducing noise and vibration.—B & K Instruments, Inc., 3044 West 106th St., Cleveland 11, Ohio.

For more information circle **306** on inquiry card.

VIBRATION STUDIES. 6-page brochure describes complete slip-sync system for visual and photographic study of vibration tests.—Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.

For more information circle **307** on inquiry card.

LABORATORY, ANALYTICAL

LAB SERVICE. 4-page Bulletin 1813 describes laboratory services offered for mass spectrometer analyses.—Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

For more information circle **308** on inquiry card.

ANALYTICAL INSTRUMENT USES. 20-page brochure titled "Selecting Instruments to Solve Your Analytical Problems" discusses the applications of instrumental analysis and its advantages.—Perkin-Elmer Corp., Norwalk, Conn.

For more information circle **309** on inquiry card.

ORSAT GAS ANALYZERS. 12-page bulletin, Publication 55-668-27, contains complete information and specifications on all models in Hays' extensive Orsat line of over 85 different models.—Hays Corp., Michigan City, Ind.

For more information circle **310** on inquiry card.

DISSOLVED-OXYGEN METER. 8-page Bulletin 58-B627 describes the three basic units and operation of the dissolved oxygen meter for surface water.—The Hays Corp., Michigan City, Ind.

For more information circle **311** on inquiry card.

SILICA-CELLS. 2-page Bulletin 746 describes silica rectangular "U" cells for spectrophotometry, colorimetry, and fluorimetry.—Beckman Scientific and Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.

For more information circle **312** on inquiry card.

SPECTROPHOTOMETER. 12-page Bulletin No. 114 discusses features, performance, construction, operation and accessories of the Cary Model 14 recording spectrophotometer.—Applied Physics Corp., 2724 South Peck Rd., Monrovia, Calif.

For more information circle **313** on inquiry card.

DATA HANDLING

MAGNETIC-TAPE PLOTTERS. 2-page Bulletin PIR842-1 describes Models 4.016 and 4.017 magnetic-tape Dataplotters.—Electronic Associates, Inc., Long Branch, N. J.

For more information circle **314** on inquiry card.

ENCODERS. 8-page Bulletin E 11-1 describes shaft-position-to-digital encoders.—Librascope, Inc., 40 East Verdugo Ave., Burbank, Calif.

For more information circle **315** on inquiry card.

DIGITAL PRINTERS. 4-page Bulletin 200 describes Data/Log Series MC-200 digital printers and calculating machines.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

For more information circle **316** on inquiry card.

PUNCHED-CARD SHORTCUT. 4-page brochure illustrates and explains the techniques by which Synchro-Tape Unit eliminates the manual jobs of card punching and verifying.—Remington Rand Div. of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.

For more information circle **317** on inquiry card.

DIGITAL INSTRUMENTATION. 4-page short form catalog illustrates and describes building-block instruments for digital data systems.—Dymec, Inc., 395 Page Mill Rd., Palo Alto, Calif.
For more information circle **318** on inquiry card.

TAPE PROCESSNG EQUIPMENT. 6-page Bulletin TPG39 describes Digitronics Dykor auxiliary tape processing equipment for off-line testing, editing, copying, interrogation and translating of magnetic tape files.—Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.
For more information circle **319** on inquiry card.

PORTABLE TAPE RECORDERS. 6-page brochure describes and illustrates new TransMagnemites transistorized, battery-operated, spring-motor portable tape recorders.—Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.
For more information circle **320** on inquiry card.

TESTING

INSULATION TESTERS. 2-page leaflet illustrates and describes Series 7000 a-c insulation testers.—Beta Electric Div. of Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn.
For more information circle **321** on inquiry card.

TEST CONSOLE. 2-page Bulletin 1382 describes 5000-psi hydraulic-components test console for the missile industry.—George L. Nankervis Co., 15400 Fullerton, Detroit 27, Mich.
For more information circle **322** on inquiry card.

ALTITUDE CHAMBERS. 2-page pamphlet presents information on Series 900 altitude-simulation chambers.—General Vacuum Corp., 400 Border St., East Boston 28, Mass.
For more information circle **323** on inquiry card.

TEST CHAMBERS. 8-page brochure contains information and descriptive data on temperature-vibration test chambers and temperature-altitude-vibration testing chambers.—Conrad, Inc., Conrad Square, Holland, Mich.
For more information circle **324** on inquiry card.

TUBING, FITTINGS

DOUBLE LAP FLARER. 6-page Catalog 1145-A16 describes a pneumatically-operated machine for forming a double lap flare on the end of ferrous and non-ferrous tubing.—Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio.
For more information circle **325** on inquiry card.

MONEL TUBING. 4-page Folder CM-159 lists chemical composition, physical constants and mechanical properties of Monel, "R" Monel, "403" Monel and "K" Monel tubing.—Superior Tube Co., Norristown, Penna.
For more information circle **326** on inquiry card.

EXTRUDED-TEFLON TUBING. 4-page Bulletin ET-59 describes line of flexible thin-wall paste-extruded tubing and spaghetti extruded Teflon.—Continental-Diamond Fibre Corp., Newark, Del.
For more information circle **327** on inquiry card.

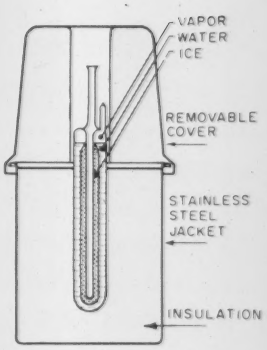
QUICK HOSE COUPLINGS. 4-page Catalog F-10-R illustrates and describes

New Temperature Standard

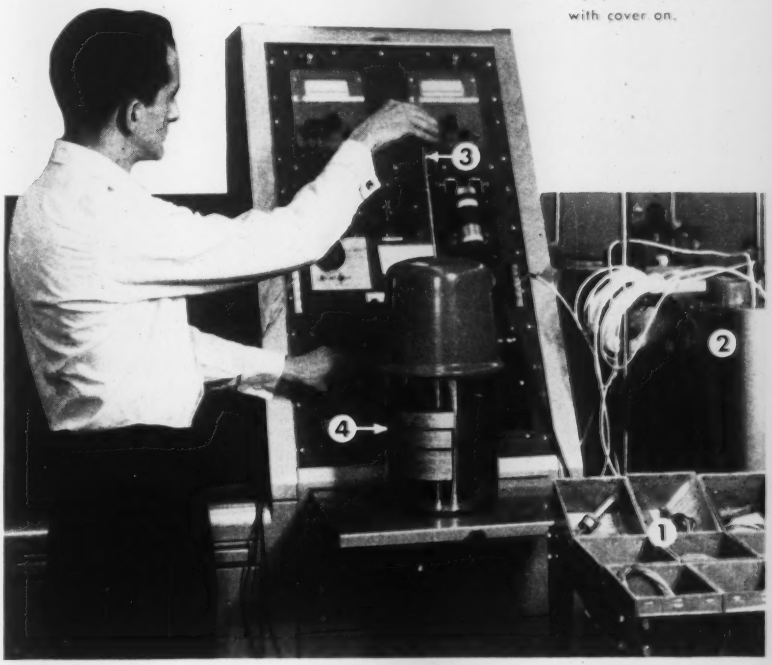
TRANS-SONICS T.M.

EQUIPHASE* CELL

assures accuracy of thermometer calibrations



Equiphase Cell shown with cover on.



The above photograph shows how an Equiphase Cell is used to assure accuracy in calibrating platinum resistance thermometers. Various types of platinum thermometers (1) to be calibrated are immersed in an ice bath (2). The temperature of the ice bath is continuously monitored by a special platinum thermometer (3) used as the working standard. Accuracy of the working standard is assured by periodic checking against the reference temperature established by the Equiphase Cell (4).

In the Equiphase Cell, pure water is partially frozen in an evacuated and non-contaminable sealed glass system to establish the triple-point-of-water (ice, water, and water-vapor at 4.58 mm Hg). By definition the triple-point-of-water is a fundamental fixed point at exactly 0.0100C on the International Temperature Scale. Equiphase Cells, meeting these exacting requirements, are now available in a convenient easy-to-use package complete with instruction booklet. Write for Equiphase Cell Technical Bulletin to Trans-Sonics, Inc., Dept. 19, Burlington, Massachusetts.

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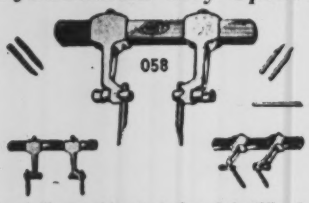

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For more information circle **155** on inquiry card.

NEW LITERATURE

Kamlok quick-coupling assemblies, and tabulates applicable metals and alloys for various chemicals.—OPW Corp., Jordan Industrial Sales Div., 6013 Wiehe Rd., Cincinnati 13, Ohio.

For more information circle **328** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

D-C AMPLIFIER. 4-page Catalog B-C2HLA-4, describes a new d-c amplifier, Model 2HLA-4a, with isolated differential input.—Minneapolis-Honeywell, Boston Div., 40 Life St., Boston 35, Mass.

For more information circle **329** on inquiry card.

AC/DC VOLTMETER. 2-page Data Sheet 19-41 describes Model 502 AC/DC digital voltmeter.—KIN TEL, Cohu Electronics, Box 623, San Diego, Calif.

For more information circle **330** on inquiry card.

UHR STANDARD BRIDGE. 2-page bulletin presents full information on Model 801 ultra-high resistance bridge.—Mid-eastern Electronics, Inc., 32 Commerce St., Springfield, N. J.

For more information circle **331** on inquiry card.

ELECTRICAL INDICATORS. 8-page Catalog 59-1 describes electrical indicators including among many items a newly-announced line of 4" Unimeters.—Triplett Electrical Instrument Co., Bluffton, Ohio.

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SWITCHBOARD INSTRUMENTS. 24-page Catalog 4220 Bulletin covers thirteen types of switchboard instruments such as a-c ammeters, a-c milliammeters, a-c voltmeters, a-c frequency meters, a-c wattmeters, synchroscopes, power factor meters, "VAR" meters, d-c ammeters, d-c milliammeters, d-c voltmeters, d-c millivoltmeters, and temperature indicators.—Roller-Smith, Inc., 50 Ave. L, Newark 1, N. J.

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ELECTRONIC INSTRUMENTS. 2-page leaflet illustrates and specifies 11 models of meters, etc., including phase meter, null meter, impedance comparators, power oscillators, frequency standard, multiplier, etc.—Industrial Test Equipment Co., 55 East 11th St., New York 3, N. Y.

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SWITCHES

SWITCHES. New condensed Catalog 608.302 describes snap-action switches, foot switches, mercury switches, and actuating switches.—PIC Automation Controls Div., General Controls Co., 8062B McCormick Blvd., Skokie, Ill.

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MANUAL RESET SWITCHES. 2-page Form 84-338, GL-2-9, describes and explains how switch detects misfeed of material in progressive die.—Micro Switch, a Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill.

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POWER SUPPLIES

MINIATURIZED POWER PACKS. 2-page Catalog Sheet 116 covers descriptive data of miniaturized magnetic-transistor regulated power packs which combine the characteristics of transistor and magnetic regulators.—Electronic Research Associates, Inc., 67 Factory Pl., Cedar Grove, N. J.

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POWER SUPPLIES. 4-page Bulletin 106 describes a new line of strain gage instrumentation and input conditioning equipment, including strain indicator, millivolt per volt standards, switching units, regulated power supplies and amplifiers for strain gage use.—Bytrex Corp., 294 Centre St., Newton 58, Mass.

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WIRE, CONNECTORS

MULTI-CONDUCTOR CABLE. 4-page Catalog Section 33 describes "Thermo-Cable," a new type of polyvinyl-insulated multiconductor cable for installing 6 to 56 pairs of thermocouple leads at one time.—Thermo Electric Co., Inc., Saddle Brook, N. J.

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POWER CONNECTORS. 2-page bulletin gives specifications, outline dimensions, and general information on Series 14 power connectors with closed-ring entry contacts.—DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.

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ELECTRICAL, ELECTRONIC COMPONENTS

CRYSTAL OVEN. 2-page Technical Bulletin RF-594 describes new miniature change-of-state crystal oven claimed to offer significant advantages over conventional bi-metallic thermostat ovens.—Aeronautical and Instrument Div., Robertshaw-Fulton Controls Co., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

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ELECTROLYTIC CAPACITORS. 4-page Bulletin 142F provides complete data on expanded line of tantalum-wire electrolytic capacitors.—Ohmite Mfg. Co., 3673 Howard St., Skokie, Ill.

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TRANSISTORIZED DECADES. 4-page Summary Catalog N-359 illustrates and describes N-Series of non-indicat-

ing and indicating plug-in decimal counters.—Engineered Electronics Co., 506 East First St., Santa Ana, Calif.
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TRANSISTOR DIGITAL CIRCUITS. 8-page catalog illustrates and tabulates Series 100 TDC's for digital equipment and system construction.—Epsco, Inc., Components Div., 588 Commonwealth Ave., Boston 15, Mass.
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WAVEGUIDE TERMINATIONS. 6-page issue of "PDR Reports," Vol. 6/No. 2 contains an article on sliding shorts, sliding terminations, and standard mismatches.—Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.
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SYNCHRO RESOLVER. 2-page Data Sheet 117-7 details full specs and data of single resolver. Series 2000C.—Lear, Grand Rapids Div., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.
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L-C TUNERS. 4-page Bulletin No. 216 contains illustrations and descriptions of electrical and mechanical characteristics of the LC tuner series.—JFD Electronics Corp., 6101 Sixteenth Ave., Brooklyn 4, N. Y.
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RF CHOKES. 2-page data sheet describes and tabulates Wee-Ductors, encapsulated, non-flammable, subminiature RF chokes.—Essex Electronics, 550 Springfield Ave., Berkeley Heights, N. J.
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MISCELLANEOUS

VIBRATION AND NOISE. 8-page Bulletin K4E gives engineering specifications and performance data for 27 types of products for the control and measurement of machinery vibration, shock, and noise.—Korfund Co., Inc., 48-355 32nd Pl., Long Island City 1, N. Y.
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FACILITIES REPORT. 8-page bulletin covers facilities for the manufacture of hundreds of highly-specialized wire, cable, and plastic products used in the missile, aircraft, electronics and communication industries.—Rex Corp., West Acton, Mass.
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COMPONENT DISPENSER. 2-page pamphlet describes and specifies a low-cost automatic electronic-component dispensing machine.—Schmit Engineering Co., 862 Fabian, Palo Alto, Calif.
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VEHICLE-DETECTING TREADLES. 4-page brochure covers line of "water-sealed" vehicle-detecting treadles.—Taller & Cooper, Inc., a div. of American Electronics, Inc., 75 Front St., Brooklyn 1, N. Y.
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VISCOSITY CONTROL. Bulletin V-1224 describes viscosity control equipment for automatically adding solvent to correct for evaporation losses.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.
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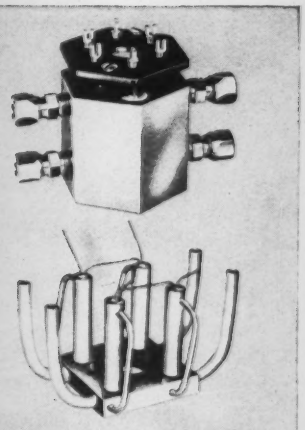
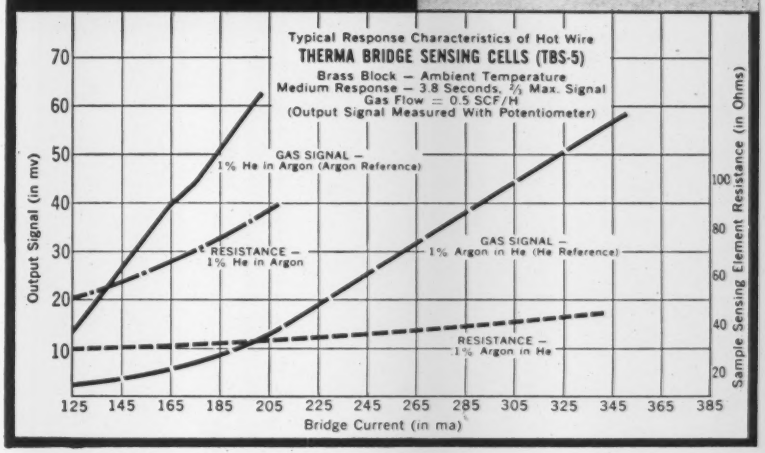


SENSING CELLS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Brass Block — Ambient Temperature
Medium Response — 3.8 Seconds, ⅔ Max. Signal
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(Output Signal Measured With Potentiometer)
GAS SIGNAL — 1% He in Argon (Argon Reference)
RESISTANCE — 1% He in Argon
GAS SIGNAL — 1% Argon in He (He Reference)
RESISTANCE — 1% Argon in He
Output Signal (in mv)
Sample Sensing Element Resistance (in Ohms)
Bridge Current (in ma)
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60
50
40
30
20
10
100
80
60
40
20
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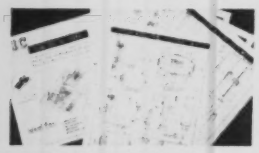

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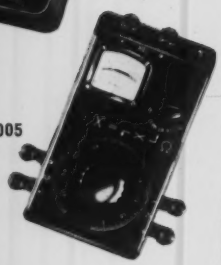

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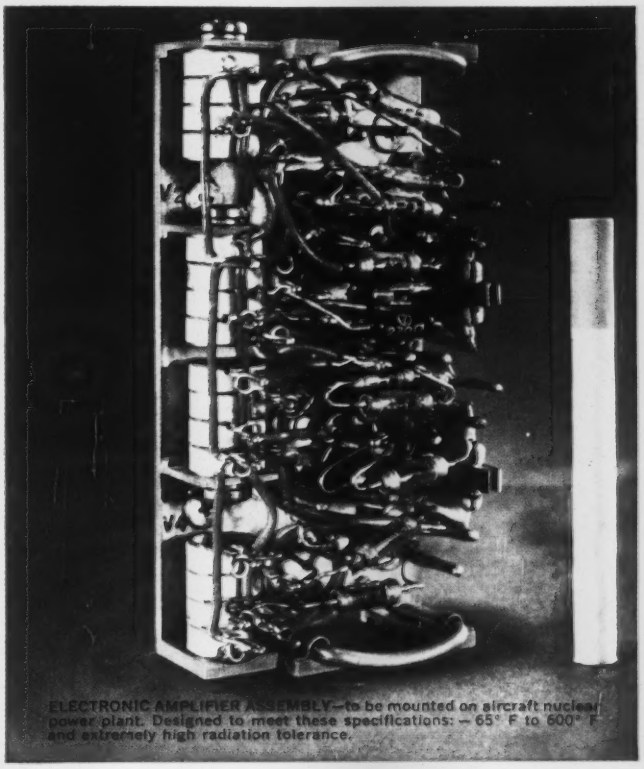

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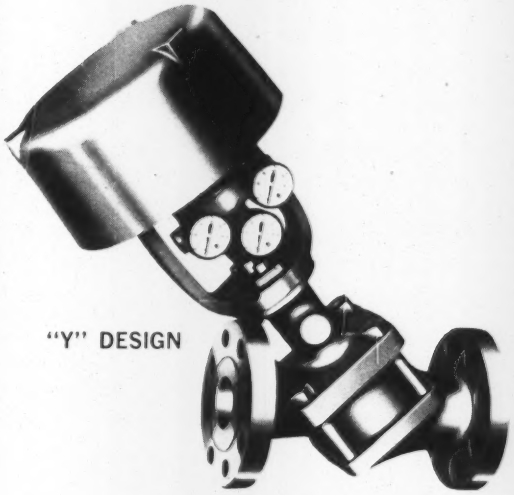

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